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INDEX TO VOLUME XCV

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INDEX, 1921

VOLUME XCV

A

Abrasive adhere to ground surface? Does.. 478§
Abrasive Machine Tool Co., Exhauster attachment for surface grinder............ 52*
Abrasive Machine Tool Co., Small sensitive vertical spindle surface grinder.......... 198*
Adams, A. D., Safety stake pocket for logging cars 719*
Air area through grates and ashpans...... 734§
Air Brake Association: A good piece of committee work .... 477§
Air Brake Association executive meeting... 362*
Air compressor, Five-step clearance control for, Ingersoll-Rand Co................. 717*
Air Compressor, Gasoline-driven portable Chicago Pneumatic Tool Co............ 527*
Air compressor pistons, Device for removing, by J. H. Hahn........................ 510*
Air compressor repair, Erie Railroad...... 191*
Air compressor units, Compact portable, Ingersoll-Rand Co. 135*
Air consumption of locomotive auxiliary devices 484*
Ajax Mfg. Co., Brake shoe key taper rolling machine 323*
Ajax Mfg. Co., New model scrap reclaiming-rolls 383*
Albert, J. J., Table for oxy-acetylene cutting 708*
Allman, Wm. N., Insulation of freight and passenger cars....................444*, 608‡
Allman, Wm. N., Reducing the fuel consumption of power plants............88*, 154
Aluminum parts for locomotives.......... 734§
American Engineering Societies' meeting.. 21
American Metal Products Co., A new electric headlight 264
American Railway Association, Division V—Mechanical, meeting postponed.......... 565
American Railway Association; The June convention program .... 669§
American Railway Bridge and Building Association (see Bridge and Building Association)
American Society of Mechanical Engineers, Problems in design and operation of large locomotives 277*
American Society of Safety Engineers, Safety code for compressed air machinery. 712
American Society for Steel Treating (see Steel Treaters' Society)
American Society for Testing Materials.... 493
American Steel Founders, Lamont six-wheel truck for freight cars.................. 254*
Amsler & Co., Alfred J., Measuring locomotive and car wheel loads................ 722*
Anderson, A. H., Straightening car ends with a pull jack.......................... 239*
Angle plate with second face and T-slot, Nelson Tool & Machine Co............ 129*
Angularity, Locomotive main rod, by William Ulrich 519*
Ann Arbor Railroad, Trailer box with lateral adjustment, J. E. Osmer............ 20*
Anthony, J. T., Important factors in design of locomotive boilers.................... 683
Apprenticeship in France................ 275§
Apprenticeship, Specialized training vs.... 734§
Apprentice work organized, Paris-Orleans.. 313*
Arbitration committee, Report of (Div. V.—Mech.) 569*
Armstrong, G. W., Notes on general shop practice at Du Bois (B. R. & P.)........ 179*
Armstrong, G. W., Revivifying the railroad shop. 341*
Ash pans, Air area through grates and.... 734§
Ashton Valve Co., Locomotive driving wheel quartering gage........................ 658*
Atchison, Topeka & Santa Fe, Air hose coupling of simple design, John Ph. Weber.. 404*
Atchison, Topeka & Santa Fe, Four efficient machine shop devices, by J. Robert Phelps. 317*
Atchison, Topeka & Santa Fe—Grinding chilled cast iron car wheels.............. 181
Atchison, Topeka & Santa Fe, Power punches and dies 50*
Austin, E. A., Emergency truck for car repairs 228*
Automatic connector (see Connector)
Automatic Machine Co., Combination clutch brake for shaping planer................ 262*
Auxiliaries, Maintenance of air operated.... 484*
Averill, E. A., The effect of the feed water heater on superheat and back pressure.... 619*

B

Babbitting furnace, An easily made, by E. A. Miller 248*
Baggage trucks, Locking device for station, C., M. & St. P........................ 30*
Bailey, Carl C., Locomotive weighing plant of large capacity...................... 749*
Bailey-Lewis, Regulating valve for liquid fuels 194*
Baily, T. F., Relative economy of electric, oil, gas and coal-fired furnaces.......... 507
Baker Bros., Boring and drilling machine.. 136*
Baker, C. B., Easily detachable hand rail column 592*
Baker, C. B., Easily detachable running board bracket 722*
Baker, R. & L. Co., Duplex compensating suspension for tractors................ 257*
Baker, R. & L. Co., Electric truck equipped with carrying ram.................... 391*
Baltimore & Ohio, Handling milk in specially constructed tank cars............ 763*
Baltimore & Ohio, The Futrell automatic train line connector.................... 102*
Bangor & Aroostook cinder pit(Bridge & Bldg. Assn.) 707*
Barholt, A. F., Pencil repairs and inexperienced foremen .... 71‡
Barnes Drill Co., Self-oiling all geared gang 406*
Basford, George M., Getting better results from railroad organizations............ 151
Basford, George M., Vitalizing locomotives to improve operation.................. 357*
Bast, P. E., Preparation and distribution of fuel 682
Bath & Co., John, Expanding internal thread micrometer 463*
Bath & Co., John, Internal micrometer of unusual design 326*
Bearing, Staggered roller, Hart Roller Bearing Co. 396*
Bearings for railway cars, Ball............ 23*
Bearings for railway cars, Ball, by E. F. Maas .... 146‡
Bearings, Some facts regarding, by Louis A. Shepard 312
Beatty Machine & Mfg. Co., Vertical bulldozer for steel car work................ 526*
Becker Milling Machine Co., Heavy planer type milling machine.................. 388*
Bellevue Industrial Furnace Co., Semi-automatic twist drill grinder.............. 400*
Belting, The effect of relative humidity on leather, by F. W. Roys................ 190*
Belt service and length of life, by F. D. Rich 37*
Belts, Chart gives power of, by W. F. Schaphorst 687*
Bertschy Engineering Co., Cone or single pulley driven shaper.................... 398*
Betts Machine Co., Heavy car wheel boring machine 653*
Billing repair card, Supplying additional information on 753
Black & Decker Mfg. Co., A new post drill. 256*
Black & Decker Mfg. Co., Eight-inch electric bench grinder 785*
Black & Decker Mfg. Co., Portable electric grinder with pistol grip.................. 469*
Blowpipes, Tests of oxy-acetylene, Bureau of Standards 449
Blue print bath, A, by A. G. Johnson...... 101
Boiler, Inspection act: A decision that may be misconstrued, by A. G. Pack........ 336§
Boiler, A scale-proof locomotive crane, Industrial Works 133*
Boiler design, Progress in................ 672§
Boiler Makers' Association (see Master Boiler Makers' Association)
Boiler ruptures with man in firebox........ 590
Boiler scale, The cost of, by W. F. Schaphorst 292*
Boiler shell cracking, Cause of, through girth and seam rivet holes (Master Boiler Makers' Assn.) 712
Boiler shop tools, Two, by E. A. Miller.... 765*
Boiler, Stool for supporting front end of, by E. A. Miller 48*
Boiler tubes (see Tubes)
Boiler welding practice, Examples of proved, by G. M. Calmbach.................... 772*
Boilers, Important factors in design of locomotive, by J. T. Anthony.............. 683
Boilers, Repairing tube-sheet cracks in locomotive 704
Boilers, The care of locomotive............ 87
Bolster attachments for metal draft arm, R. C. Taft.............................. 130*
Bolt puller, Frame........................ 340*
Booster applied to Mikado locomotives for the Nickel Plate........................ 737*
Booster, Self-adjusting wedge, feed water heater and (Traveling Engineers' meeting) 616
Booth for timekeepers and foremen, Metal, Lyon Metallic Mfg. Co.................. 406*
Borden Co., Ratchet die stock.............. 408*
Boring mill, Taper attachment applied to, Cincinnati Planer Co.................. 53*
Boring mill (see Machine Tools)
Boston & Albany, A welded locomotive tender tank, by J. W. Murphy............ 550*
Bouysov, M. A., Turntable indicating device 688*
Bowen Motor Railways Corp., Gasoline motor driven passenger car (Pittsburg & Shawmut) 697*
Brake, Demonstration of double-capacity, Virginian Railway 428*
Brake equipment, Safety hand, Minich Railway Appliance Corp...................... 472*
Brake, Final trials of Kunze-Knorr air..... 218†
Brake for shaping planer, Combination clutch, Automatic Machine Co.................. 262*
Brake heads for uniform shoe wear, Designing, by H. M. P. Murphy.............. 107*
Brake power on tank cars, Adjustment of.. 227
Brake shoe and brake beam equipment, Report on (Div. V—Mech.)................ 579*
Brake shoe key taper rolling machine, Ajax Mfg. Co. 323*
Brass, The heat treatment of copper and, by F. H. Helrigel (Steel Treaters' convention) 647
Brexton, George, Reaming tube sheet holes... 318*
Bridge & Bldg. Assn., Construction and maintenance of cinder pits.............. 707*
Bridgeport Safety Emery Wheel Co., Heavy duty motor driven face grinder.......... 126*
Brinckerhoff, Frank M., The safety of passengers in steel railway cars.............. 223*
British views on fuel-oil installations....... 764
Bronze, Welding cylinders with Tobin, by Joseph T. Paight........................ 374*
Brookes, John H., Assigning engines........ 71‡
Brown & Sharpe Mfg. Co., Easily applied high speed milling attachment............ 51*
Brown & Sharpe Mfg. Co., Improved tools for machinists and toolmakers............ 389*
Brown Instrument Co., Cold junction compensated pyrometer...................... 595*
Brown Instrument Co., Long distance recording thermometers 471*
Brush for cleaning metal surfaces, Wire, Ingersoll-Rand Co. 387*
Brush for cleaning operations, Rotary wire, Independent Pneumatic Tool Co.......... 257*
Buck, D. M., Rusting of steel containing copper .... 538‡
Buckeye Steel Castings Co., Six-wheel freight car truck 522*
Buell, D. C., Standards of fuel economy (Fuel convention) 425
Buffalo, Rochester & Pittsburgh, An improved locomotive throttle valve, by W. J. Knox 216*

* Illustrated article; § editorial; † short, non-illustrated article or note; ‡ communication.

- Buffalo, Rochester & Pittsburgh cinder pit (Bridge & Bldg. Assn.) 707*
- Buffalo, Rochester & Pittsburgh, Notes on general shop practice at Du Bois, by George W. Armstrong 179*
- Buffing machine, Electric grinder and, U. S. Electrical Mfg. Co 390*
- Bulldozer for steel car work, Vertical, Beatty Machine & Mfg. Co 526*
- Bureau of Explosives, Annual report of the. 298
- Bureau of Explosives, Tank car outlets and other projections 170
- Bureau of Locomotive Inspection, Report of the 18*
- Bureau of Safety, Annual report of the 29
- Bureau of Standards, Tests of oxy-acetylene blowpipes 449

Books

- Air Brake Association proceedings for 1921 736
- Cams, Elementary and advanced, by Frank De Ronde Furman 276
- Coal trade, Saward's annual statistical review of the 538
- Developing executive ability, by Enoch Burton Gowin 146
- Engineering index for 1919, The, A. S. M. E. 4
- Engineering index, The, A. S. M. E. 480
- Engineering instruments and meters, by Edgar A. Griffiths 480
- Export register of the Federation of British Industries 4
- Fuel economy on locomotives, American Railway Association 480
- Fuel oil in industry, by Stephen O. Andros 4
- Locomotive up to date, The, by Charles McShane 4
- Locomotives, Simple superheated steam, by Eugene Bruckmann 276
- Master Boiler Makers' Assn. committee reports 672
- Powdered coal as a fuel, by C. F. Herington 146
- Practical locomotive running and management, by W. G. Knight 72
- Proceedings of the International Railway Fuel Assn 336
- Railroad shop practice, by Frank A. Stanley 672
- Standard details, Handbook of, by Charles H. Hughes 480
- Steam locomotives of the present time, by Robert Garbe 210
- UC equipment, Questions and answers on the, Air Brake Assn 736
- Welding encyclopedia, by L. B. MacKenzie and H. S. Card 210

C

- Cab apron holder, by E. A. Miller 702*
- Cairns, J. M., Chuck for holding hose nuts 181*
- Calipering driving wheels and tires, Gage for, by E. A. Miller 242*
- Calmbach, G. M., Standards of railroad shop welding practice 772*
- Canadian Pacific, New sleeping cars for the. 691*
- Candy, A. M., Electric arc welding in railroad shops 456*
- Carbon dioxide recorders, Redesigned, Uehling Instrument Co 133
- Car construction committee, Report of (Div. V—Mech.) 572*
- Car inspectors and foremen propose changes in rules of interchange 233, 304, 375, 441
- Carlton Machine Tool Co., Ball bearing heavy duty radial drill 386*

Car

- Bad order, 14.2 per cent 335§
- Bad order: A difficult problem 69§
- Bad order: An eye to the future 209§
- Bad order: A unit that will measure 1§
- Bad order, reached maximum in August 635*
- Bad order situation, Causes of the present, J. E. Muhlfeld 738
- Bearings (see Bearings)
- Bolster attachments for metal draft arm, R. C. Taft 130*
- Box, Fix, or have them retired 3§
- Brakes (see Brakes)
- Equipment, Standardizing 506
- Cost of, in 1920 80*
- Coupler (see Coupler)
- Deterioration, Relative effect of time and service on 238
- Draft gear (see Draft gear)
- Ends, Straightening, with a pull jack, by A. H. Anderson 239*
- Frame, An efficient straightening, N. B. Messimer (N. Y. C.) 31*
- Freight, Cause of the present condition of, by J. C. Fritts 97
- Freight: What are the real remedies? 69§
- Grain, Coopering 694
- Handling of, A check on rough 696

Car—Continued

- Insulation of freight and passenger, by Wm. N. Allman 448*, 608‡
- Insulation of passenger and refrigerator, by Arthur J. Wood 547*
- Interchange, Car inspectors and foremen propose changes in rules of 233, 304, 375, 441
- Interchange rules: Make car owners' responsibility complete, by C. J. Wymer 695
- Loaded: The business situation 273§
- Loaded, Unnecessary transferring of 690
- Maintenance (see Maintenance)
- Ordered and built in 1920 77
- Repairs (see Repairs)
- Seat, New coach, Scarritt Car Seat & Mfg. Co. 467*
- Seat, Single Pedestal swivel type, Frank Smolar 125*
- Stake pocket for logging, Safety, A. D. Adams 719*
- Tank outlets and other projections, Bureau of Explosives 170
- Hopper, Thawing frozen, by E. A. Miller 638*
- Truck (see Truck)
- Weak, New lease of life for 536§
- Wheels (see Wheels)
- Wood, The use of, in freight construction, by H. S. Sackett 105

Cars

- Coaches, Illinois Central steel suburban 755*
- Coal, 100-ton, for the Chesapeake & Ohio 627*
- Coal, 120-ton, on the Virginian Railway, 163*, 228
- Coal, Norfolk & Western 100-ton, by John A. Pilcher 293*, 367*
- Container, in express service on the N. Y. C. 171*
- Container, in use in Poland, S. Rodowicz 689*
- Design, Henry Ford on 670§, 689
- Design, Notable innovation in, Freight. 274§
- Design, Suggestions for passenger, by George S. Clouser 754
- Diesel electric, on the Swedish Railways 156*
- Freight, Factors to be considered in designing, by Albert H. Lake 495
- Gasoline motor, for branch line service 670§
- Passenger, Gasoline motor driven, Bowen Motor Railways Corp. (Pittsburg & Shawmut) 697*
- Postal, New plans and specifications for, and fixtures 101*
- Refrigerator, Fruit express, Union Pacific 25*
- Sleeping, New, for the Canadian Pacific 691*
- Tank, Handling milk in specially constructed, Baltimore & Ohio 763*
- Tank, Report of committee on (Div. V—Mech.) 586
- Tank, Sulphuric acid, of 70 tons capacity, General Chemical Co 95*

- Case-hardening, The effect of temperature in, by Theodore G. Selleck 648*
- Castings, An alloy for high temperature, Electro Alloys Co 654*
- Castings, Bronze-faced semi-steel 670§
- Castings improved by research, Malleable 643*
- Cast iron cutting 310
- Cast iron, Limitations of Thermit welding for repairing 38*
- Causey, James, Locomotive cylinder welding (Wabash Railway) 191*
- Centering machine, Double spindle, Hendey Machine Co. 399*
- Centering sleeve, Piston rod, by E. A. Miller 252*
- Central of New Jersey, Machine forging at Elizabethport 769*
- Chain, Electric welded. Columbus McKinnon Chain Co. 405*
- Champion Engineering Co., Driving mechanism for roundhouse crane 528*
- Chapman, W. H., Cylindrical grinding in 1920 109
- Chemical limits specified for iron car wheels 477§
- Chesapeake & Ohio, 100-ton coal cars for the 627*
- Chicago, Milwaukee & St. Paul, Locking device for station baggage trucks 30*
- Chicago, Milwaukee & St. Paul, Power punches and dies 49*
- Chicago, Milwaukee & St. Paul, Widening the outlook of the local car foreman, by L. K. Sillcox 371*
- Chicago Pneumatic Tool Co., Electric hammer drill of novel design 263*
- Chicago Pneumatic Tool Co., Gasoline-driven portable air compressor 527*
- Chicago, Rock Island & Pacific, A visit to Silvis shops, by S. W. Mullinix 365*
- Chicago, Rock Island & Pacific, Mountain type locomotives for the 147*
- Chicago, Rock Island & Pacific, Liberty flue cutter 184*
- Chief Interchange Car Inspectors' and Car Foremen's Assn. (see Car Inspectors' and Car Foremen's Assn.)
- Chipping screen, An improved, by A. G. Johnson 518*
- Chuck, Driving box, by E. A. Miller 250*
- Chuck for face grinder, Sectional wheel, Diamond Machine Co 401*
- Chuck for holding hose nuts by J. M. Cairns 181*
- Chuck for use with broken twist drills, Wayne Tool Mfg. Co 718*
- Chuck, Toothed key and sleeve type, Jacobs Mfg. Co. 324*
- Chucks, Pilot bar and drill press, Frontier Chuck & Tool Co 198*
- Cincinnati Electrical Tool Co., Combination grinding and buffing machine 266*
- Cincinnati Electrical Tool Co., Portable electric drill with pistol grip 720*
- Cincinnati Milling Machine Co., A dynamometer for milling machines 596*
- Cincinnati Planer Co., Taper attachment applied to boring mill 53*
- Cincinnati Planer Co., Thirty-inch shoe and wedge planer 129*
- Cinder pits, Construction and maintenance of (Bridge & Bldg. Assn.) 707*
- Clark, J. C., Management in railroad shops. 6‡
- Clark-Mesker Co., Motor drive for milling machines 134*
- Clark-Mesker Co., Rotary table for milling machines 266*
- Cleaner, Non-volatile liquid, Dearborn Chemical Co. 404
- Cleveland, Cincinnati, Chicago & St. Louis, A profitable railroad reclamation project. 185*
- Cleveland, Cincinnati, Chicago & St. Louis, Planer type milling machine makes record, by Jacob Martin 766*
- Cleveland, Pierre, Characteristic heat treatment curves 775*
- Cleveland Pneumatic Tool Co., New design of pressure seated valve 403*
- Clouser, George S., Suggestions for passenger car design 754
- Clubs, The problem of railroad 2§
- Coal, Recent developments in the storage of 626*
- Coalometer, F. C. Thornley & Co 58*
- Colburn Machine Tool Co., High power vertical turning and boring mill 462*
- Coleman Boiler Appliance Co., Tube safe end with square shoulder 127*, 266
- Collett, Robert, Value of individual fuel performance records (Fuel convention) 426
- Columbus McKinnon Chain Co., Electric welded chain 405*
- Combustion chambers, Length of tubes and. 734§
- Combustion chambers, Maintenance cost of 418§
- Compressed air machinery, Safety code for American Society of Safety Engineers 712
- Coudrey, I. H., The efficacy of annealing overstrained steel (Steel Treaters' convention) 647
- Conneaut Shovel Co., Lightweight shovel for molders and locomotive firemen 467*
- Connector, The automatic train line connector, Futrell Coupler Co. (B. & O.) 102*
- Conté, Paul, European view of steel vs. copper fireboxes 685*
- Conventions: Mechanical associations on the defensive 605§
- Coopering cars for grain 694
- Copper and brass, The heat treatment of, by F. H. Helrigel (Steel Treaters' convention) 647
- Cost of living and productive efficiency Wages 416§
- Coupler, An auxiliary car, by Norman MacCleod 564*
- Coupler and hose connector, A combined car, Universal Car & Hose Coupler Co. 699*
- Coupling of simple design, Air hose, John Ph. Weber (A., T. & S. F.) 404*
- Covington Machine Co., Hose dismantling and assembling machine 782*
- Cowan Truck Co., Self-loading type electric truck 52*
- Cowan Truck Co., Improved electric self-loading truck 401*
- Crane, Driving mechanism for roundhouse, Champion Engineering Co 528*
- Crane for erecting shop, Gap, H. K. Ferguson Co. 259*
- Crosshead babbitting devices 187*
- Crosshead, Recent improvements in adjustable, Rogatchoff Co 785*
- Cut-off control, Locomotive 478§
- Cut-off, The automatic control of locomotive, by E. S. Pearce 488*
- Cutler-Hammer Mfg. Co., Rigidly constructed auto-transformer starter 261*
- Cut-offs, The importance of checking 274§
- Cutter for facing off welded tube ends, by E. A. Miller 765*
- Cutters for wheel lathes, Drop forged, Forge Products Corp 784*
- Cutting: Does gas-cutting always pay? 672§
- Cutting in railroad shops, Gas machine 705*
- Cutting, Inclining the torch when 706
- Cutting, Table for oxy-acetylene, by J. J. Albert 708*
- Cutting tests, Oxy-acetylene, by John C. Eichner 713
- Cutting torch: The Radiagraph 705*
- Cylinder cap of air compressor governor, Repairing 48*
- Cylinder cock which closes when engine drifts, L. P. Ligon 323*

Cylinder tests on Southern Pacific, Long stroke 613*
Cylinders, Welding locomotive, by C. E. Farley 247*

D

Damage to merchandise: A chemist in a freight car, by H. J. Force.... 700
d'Arcambal, A. H., Physical tests of high speed steel (Steel Treaters' convention).. 646
Dearborn Chemical Co., Non-volatile liquid cleaner 404
De Boysson, M., Fuel conditions on the French railways 562
Delaware, Lackawanna & Western, A Surgical operation performed on a locomotive valve port, by M. R. Feeley.... 508*
Delaware, Lackawanna & Western, Modern equipment facilitates flue shop work.... 554*
Deterioration, Relative effect of time and service on car.... 238
Diamond Machine Co., Small high duty surface grinder 193*
Diamond Machine Co., Improved method of crowning pulleys 324*
Diamond Machine Co., Sectional wheel chuck for face grinder.... 401*
Dickinson, H. H., The requirements for a modern car repair shop.... 759*
Die blocks, Hardening hammer, by R. B. Kerr 252
Die head for pipe threading machine, Receding, Williams Tool Corp.... 721*
Die heads, Automatic self-opening, Eastern Machine Screw Corp.... 199*
Die heads, Self-opening and adjustable, Geometric Tool Co.... 470*
Die heads, Self-opening and adjustable, Modern Tool Co.... 398*
Die stock, Ratchet, Borden Co.... 408*
Discussions: The problem of the railroad clubs .... 2§
Dittman, George, Safety cold water sprinkler 196*
Dixon Crucible Co., Joseph, Lubricant for hub liners 56
Dixon, W. J., Method for squaring Walschaert valve gear.... 189*
Draft gear tests of the railroad administration....144§, 173, 229, 301*, 435*, 497*
Drill, Making a, live up to its reputation, by H Wills.... 249*
Drill, New drive for heavy duty radial, Fosdick Machine Tool Co.... 132*
Drill stand and removable drill, Radial, Hisey-Wolf Machine Co.... 201*
Drilling Machines (see Machine Tools).
Driving box chuck, by E. A. Miller.... 250*
Driving boxes, Application of shoe and wedge liners to.... 248*
Driving box shoes and wedges, Bronze-faced, Standard Semi-Steel Foundry Co.. 719*
Driving boxes, Machining.... 310*
Driving wheels (see Wheels).
Drop pits at terminals on the South African railways, by John D. Rogers.... 677*
Duluth & Iron Range, Step ladder for car shops, by Austin G. Johnson.... 590*
Duluth, Missabe & Northern cinder pit (Bridge & Bldg. Assn.).... 707*
Dunn, Samuel O., The present railway situation (Fuel convention).... 423
Dynamometer for milling machines, A., Cincinnati Milling Machine Co.... 596*

E

Earle Gear & Machine Co., Cold metal saw for heavy duty.... 396*
Eastern Machine Screw Corp., Automatic self-opening die heads.... 199*
Eastern Machine Screw Corp., Redesigned trip levers for die heads.... 263*
Eastern Machine Screw Corp., Single and double spindle threading machines.... 394*
Edlund Machinery Co., Drilling machine with nut facing fixture.... 397*
Efficiency: A need for fundamental data... 417§
Efficiency: Order vs. disorder.... 671§
Eichner, John C., Oxy-acetylene cutting tests 713
Electrification again proposed, Comprehensive .... 735§
Electric welding (see Welding).
Electrifying section of eleven railroads, Plan for 739*
Electro-Alloys Co., An alloy for high temperature castings 654*
Emery wheel dresser, Guard for, by E. A. Miller 702*
Engine terminals: An operating factor, by L. G. Plant.... 15*
Engine terminals, Modernizing existing, by G. W. Rink 73*
Engine terminals, Needs of smaller.... 535§
Engine terminal development.... 535§
Equipment on the Tomsk railway, Mechanical, by James Grant.... 7*
Erie railroad, An air compressor repair.... 191*
Erie railroad, A new rod design.... 218*
Erie railroad, Test of stoker fired locomotive over three divisions.... 215
Exhaust nozzle, Automatic variable, by Clarence Roberts 494*
Exhaust steam injector, The advantages of the, by Clarence Roberts.... 290*
Exhauster attachments for surface grinder, Abrasive Machine Tool Co.... 52*
Expenses: Getting back to normal.... 479§
Explosion at Memphis, Gasoline, Union Railway 162

F

Fafnir Bearing Co., Double ball bearing hanger boxes 325*
Farley, C. E., Welding locomotive cylinders 247*
Federated American Engineering Societies' meeting (see American Engineering Societies)
Feed control, Oil-pressure transmission and, Oilgear Co. 659*
Feed recording device, Speed and, O. Zernickow 407*
Feed water heater and booster, Self-adjusting wedge (Traveling Engineers' meeting) 616
Feed water heater on superheat and back pressure. The effect of the, by E. A. Averill 619*
Feed water heating, Locomotive (Fuel convention) 425
Feed valve testing device, by Norman McCleod 644*
Feeley, M. R., A surgical operation performed on a locomotive valve port (D., L. & W).... 508*
Ferguson Co., H. K., Gap crane for erecting shop 259*
Firebox tube-sheet cracks in locomotive boilers, Repairing 704
Fireboxes, European view of steel vs. copper, by Paul Centé.... 685*
Flinner, John, Emergency seat refacing tool 184*
Flue cutter, Liberty, C. R. I. & P.... 184*
Flue expander, Six-roll superheated.... 768
Flue shop work, Modern equipment facilities (D. L. & W.).... 554*
Flue welding machine, Universal, Southwark Foundry & Machine Co.... 391*
Force, H. J., A chemist in a freight car... 700
Force, H. J., Some failures of chilled-iron car wheels 505
Ford, Henry, comments on car design.... 689
Ford-Smith Machine Co., Cone drive plain milling machine 259*
Foremen local managers, Making.... 336§
Foreman, The, a business man.... 143§
Foreman, Widening the outlook of the local car, by L. K. Sillcox (C. M. & St. P.).. 371*
Foremen's courses, Right kind of.... 276†
Foreman, Selecting, by John Mitchell.... 209‡
Foreman, The; his qualifications and training, by L. E. Gardner.... 459
Foremanship: Encourage the man down the line .... 607§
Forge, Portable rivet heating, Norton Mfg. Co. 200*
Forge Products Corp., Drop forged cutters for wheel lathes.... 784*
Forging at Elizabethport, Machine, Central of New Jersey.... 769*
Forging, Production machine.... 733§
Fosdick Machine Tool Co., New drive for heavy duty radial drill.... 132*
Fosdick Machine Tool Co., Twenty-one inch heavy duty upright drill.... 395*
Frame failures, Curing troublesome, by Frank Roberts 252*
Frames, Device for spreading locomotive, Yazoo & Mississippi Valley.... 380*
Franklin Railway Supply Co., Precision power reserve gear.... 470*
French railways, Fuel conditions on the, by M. De Boysson.... 562
Fritts, J. C., Cause of the present condition of freight cars.... 97
Front ends, Paint spraying locomotive.... 124*
Frontier Chuck & Tool Co., Pilot bar and drill press chucks.... 198*
Fry, Lawford H., Notes on the comparison of locomotive dimensions.... 211
Fuel accounting 546
Fuel Association, Annual convention of the. 423*
Fuel conditions on the French railways, by M. De Boysson.... 562
Fuel consumption of power plants, Reducing the, by William N. Allman....88* 154
Fuel economy by accurate valve setting, by J. McAllister 311*
Fuel economy, Standards of, by D. C. Buell (Fuel convention) 425
Fuel, Preparation and distribution of, by P. E. Bast 682
Fuel performance records, Value of individual, by Robert Collett (Fuel convention) 426
Fuel, Pulverized lignite as locomotive.... 487
Fuel, Save, by keeping valves square, by W. G. Landon.... 6‡
Fuel, Stop Waste of, at the source.... 537§
Fuel under steam boilers, The use of powdered, by H. D. Savage.... 589
Fuel-oil installations, British views on.... 764
Fuels, Regulating valve for liquid, Bailey-Lewis 194*
Furnace, An easily made babbitting, by E. A. Miller.... 248*
Furnace, The electric, as it affects overall cost of heat treated parts, by C. L. Ipsen (Steel Treaters' convention).... 647
Furnaces, Relative economy of electric, oil gas and coal-fired, by T. F. Baily.... 507
Futrell Coupler Co., The automatic train line connector (B. & O.).... 102*

G

Gage for calipering driving wheels and tires, by E. A. Miller.... 242*
Gage for detecting worn arch tubes, by E. A. Miller....765*
Gage, Locomotive driving wheel quartering, Ashton Valve Co.... 658*
Gages facilitate repairing valves in air brake department, Standard, by P. A. Skinner 49*
Gage, Driving box.... 178*
Gages and progressive sizes, Limit, by Col. H. E. O'Brien....177
Gallagher, F. S., Periodical repairs for freight cars.... 24
Gardner, Henry, Scheduling and routing systems for car shops.... 502
Gardner, J. E., Electric power and light for railroad shops 515
Gardner, L. E., the foreman; his qualifications and training.... 459
Gardner Machine Co., Continuous feed disc grinding machine.... 59*
Gas analyzer, Flue, Mono Corp. of America 195*
Gas in railroad shops, The use of, by Roy G. Monroe.... 458
Gate, Shop safety 106*
Gear pattern cutting attachment, Oliver Machinery Co.... 593*
General Chemical Co., Sulphuric acid tank cars of 70 tons capacity.... 95*
General Electric Co., Welding sets for medium and heavy duty.... 779*
General Engineering Accessories, Fibrous metallic packing for general use.... 263
Geometric Tool Co., Self-opening and adjustable die heads.... 470*
Geometric Tool Co., Three-quarter inch double spindle threader.... 402*
Gibbs, W. E., Steam hammer repair.... 558*
Gibson, grant, A locomotive repair shop scheduling system....243*
Gibson, Grant, A system of progressive shop discipline 319*
Giltinan, D. M., The metallurgy of high speed steel.... 709*
Glow Electric Co., Double annular ball bearing floor grinder.... 394*
Golden-Anderson Valve Specialty Co., Automatic, non-return valves.... 258*
Gower, J. T., What insulation will do for the heat treater (Steel Treaters' convention) 646
Graham Mfg. Co., Knee-type surface grinding machine 717*
Grant, James, Mechanical equipment on the Tomsk railway 7*
Grates and ash pans, Air area through.... 734§
Gray Co., G. A., New planer designed for maximum service 777*
Grease grooves, Driving box, L. P. Ligon.. 469*
Grease gun, Pneumatic, by Norman MacCleod 455*
Grease lubrication, by T. J. Holmes.... 76
Grease plug holes. Jig for use in drilling, by E. A. Miller.... 702*
Great Northern of England, An accomplishment in light reciprocating locomotive parts 286*
Grinder (see Machine Tools)
Grinding, A few points on, by Charles H. Norton 514
Grinding data desired, Car wheel, by E. Thomas .... 736§
Grinding in 1920, Cylindrical, by W. H. Chapman 109
Grinding sparks as a measure of carbon content, by D. H. Stacks (Steel Treaters' convention) 646
Grooving device, Driving box.... 192*
Grossman, M. A., The toughness of high speed steels as affected by their heat treatment (Steel Treaters' convention).. 646
Gustin-Bacon Mfg. Co., Locomotive throttle rod stuffing box.... 720*

H

Hahn, J. H., Device for removing air compressor pistons 510*
Hahn, J. H., Hydraulic rod bushing press (Norfolk & Western).... 776*
Hahn, J. H., Jig for machining reversing valve bushing seats.... 553*
Hahn, J. H., Truck for driving boxes.... 518*
Haig, M. H.. The design of large locomotives (A. S. M. E.) 277*
Hammers, Cost of air vs. steam for operating, by G. H. Richey.... 450

* Illustrated article; § editorial; † short, non-illustrated article or note; ‡ communication.

Hand rail column, Easily detachable C. B. Baker 592*
Hanger boxes, Double ball bearing, Fafnir Bearing Co. 325*
Hardness testing machine, Combination, Riehle Bros., Testing Machine Co. 656*
Hart Roller Bearing Co., Staggered roller bearing 396*
Harter circulating plates 609
Hassett, J. C., The New Haven Mountain type locomotives 5‡
Headlight, A new electric, American Metal Products Co. 264
Heald Machine Co., New motor drive for internal grinder 53*
Heald Machine Co., Power feed internal grinding machine 60*
Heald Machine Co., Self-contained internal grinder 200*
Heat treating, For a sound knowledge of 71§
Heat treating steel in railway shops, by Henry Otto 47*
Heat treatment curves, Characteristic, by Albert M. Portevin and Pierre Cleveland 775*
Heat treatment of copper and brass, The, by F. H. Helrigel (Steel Treaters' convention) 647
Heat treatment of steel, Uniform by H. C. Loudenbeck 309
Heat treatment, Responsibility for 2§
Heating apparatus, Tests of steam, (Air Brake Assn) 362*
Helrigel, F. H., The heat treatment of copper and brass (Steel Treaters' convention) 647
Hendey Machine Co., Double spindle centering machine 399*
Hennessy Lubricator Co., A positive mechanical journal lubricator 466*
Hisey-Wolf Machine Co., Radial drill stand and removable drill 201*
Hoist of novel design, Air-operated, Sullivan Machinery Co. 527*
Hoist used on the Tomsk railway, Hand or motor operated locomotive 12*
Holder corrects spindle misalinement, Floating, McCrosky Tool Corp. 530*
Holder of simple design, Clutch tap and die, Warner & Swasey Co. 526*
Holmes, T. J., Grease lubrication 76
Hclz & Co., Measuring locomotive and car wheel loads 722*
Hoofer Mfg. Co., Pneumatic crude oil flange lubricator 525*
Hose connector, A combined car coupler and, Universal Car & Hose Coupler Co. 699*
Hose couplings for pneumatic tools, Ingersoll-Rand Co. 55*
Hose dismantling and assembling machine, Covington Machine Co. 782*
Hose, Save labor in refitting 735§
Hot boxes (see Journal Boxes)
Houston, Stanwood & Gamble Co., Plate press with sectional dies 264*
Houston, Stanwood & Gamble Co., Sixty-inch lathe of exceptional power 464*
Hydraulic Press Mfg. Co., Special hydraulic driving wheel press 598*

I

Illinois Central steel suburban coaches 755*
Independent Pneumatic Tool Co., Rotary wire brush for cleaning operations 257*
Industrial Works, A scale-proof locomotive crane boiler 133*
Ingersoll-Rand Co., Compact portable air compressor units 135*
Ingersoll-Rand Co., Five-step clearance control for air compressor 717*
Ingersoll-Rand Co., Hose couplings for pneumatic tools 55*
Ingersoll-Rand Co., Wire brush for cleaning metal surfaces 387*
Inspection of standard materials, Report of joint committee on (Div. V-Mech.) 569
Insulation of freight and passenger cars, by Wm. N. Allman 444*, 608‡
Insulation of passenger and refrigerator cars, by Arthur J. Wood 547*
Insulation will do for the heat treater, What, by J. T. Gower (Steel Treaters' convention) 646
Interchange, Car inspectors and foremen propose changes in rules of 233, 304, 375, 441
Interchange rules: Make car owners' responsiblity complete, by C. J. Wymer 695
International Railway Fuel Association (see Fuel Association)
Ipsen, C. L., The electric furnace as it affects overall cost of heat treated parts (Steel Treaters' convention) 647

J

Jack, Universal type suspension journal, Joyce-Gridland Co. 524*
Jacobs Mfg. Co., Toothed key and sleeve type chuck 324*
Johnson, A. G., An improved chipping screen 518*
Johnson, A. G., A blue print bath 101
Johnson, A. G., Step ladder for car shops (Duluth & Iron Range) 590*
Johnson, A. G., Truck for handling jacket iron 118*
Jones, J. J., Method of laying out Walschaert valve gear 744*
Journal boxes, Means of preventing hot, by J. C. Stewart 440
Journal packing reclamation 104*
Joyce-Gridland Co., Universal type suspension journal jack 524*

K

Keller Pneumatic Tool Co., Rotary piston pneumatic grinder 408*
Kempsmith Mfg. Co., Plain milling machine for medium heavy work 57*
Knox, W. J., An improved locomotive throttle valve (B. R. & P.) 216*
Kronheimer, L. S., The union viewpoint on labor questions 5‡
Kunze-Knorr air brake, Final trials of 218†

L

Labor
  Labor Board announces general wage reduction 379
  Labor Board lifts piecework ban 701
  Labor Board hearings on working conditions 92, 160, 219, 287*, 559
  Labor questions, The union viewpoint on, by L. S. Kronheimer 5‡
  Policy of the Railway Mechanical Engineer 3§
  Seniority rules, One effect of 274§
  Seniority ruling, The effect of a 144§

Ladder for car shops, Step, by Austin G. Johnson (Duluth & Iron Range) 590*
Ladle, Helical worm-geared crane, Whiting Corp. 201*
Lake, Albert H., Factors to be considered in freight car designing 495
Lamont six-wheel truck for freight cars, American Steel Foundries 254*
Lancashire & Yorkshire, An English locomotive repair system, by Col. H. E. O'Brien 119*
Landis Tool Co., Internal grinder for irregular parts 529*
Landon, W. G., Are American roads prejudiced against compounds 276‡
Landon, W. G., Save fuel by keeping valves square 6‡
Lathe (see Machine tools)
Lathe lead screw variator device, Precision & Thread Grinder Mfg. Co. 403*
Lathe: An old friend 275§
Lathe of unusual length, Wood turning, Oliver Machinery Co. 134*
Lathe practice, Turret 71§
Lathe practice, Railroad shop, turret, by Howard Volz 111*
Lawrence, G. M., Improving a shop by a limited expenditure 355*
Lehigh Valley cinder pit (Bridge and Building Association) 707*
Level, A new precision machine alining, Universal Boring Machine Co. 660*
Light for railroad shops, Electric power and, by J. E. Gardner 515
Lignite as locomotive fuel, Pulverized 487
Ligon, L. P., Cylinder cock closes when engine drifts 323*
Ligon, L. P., Driving box grease grooves 469*
Liners, Application of shoe and wedge, to driving boxes 248*
Lister, F. G., Comment on the purchase of machine tools 736§
Loading rules, Report of committee on (Div. V., Mech.) 576*
Locking device for station baggage trucks, C. M. & St. P. 30*
Locomotive weighing plant of large capacity, by Carl C. Bailey 749*

Locomotive
  Aluminum parts for 734§
  Appurtenances, Conservation of supplies and in operation of (Traveling Engineers' meeting) 614
  Assigning, by John H. Brookes 71‡
  Boiler (see Boiler)
  Cost of, in 1920 80*
  Cut-off control 478§
  Cut-off, The automatic control of locomotive, by E. S. Pearce 488*
  Cylinders (see Cylinders)
  Dimensions and proportions of British, The comparison of, by E. C. Poultney 539, 621*
  Dimensions, Notes on the comparison of by Lawford H. Fry 211
  Efficiency, Pyrometers promote 433*
  Exhaust steam injector, The advantages of the, by Clarence Roberts 290*
  Foot-pound vs. the horsepower, The 418§
  Frames (see Frames)

Locomotive—Continued
  Freight, Economic advantages of large, by A. F. Stuebing 346
  Front end (see Front End)
  Headlight (see Headlight)
  Improvements in, Suggestions for, by John Mitchell 434
  Inspection, Report of the Bureau of Locomotive 18*
  Old, increasing the capacity of, by C. B. Smith 84
  Operation, Vitalizing, to improve operation, by George M. Basford 357*
  Ordered and built in 1920 77
  Pins and bushings, Advantages of standard motion 2§
  Pins and bushings, Standard valve motion, by M. H. Williams 39*
  Reciprocating parts, An accomplishment in light, Great Northern of England. 286*
  Repairs (see Repairs)
  Sheds, Why build firing-up 145§
  Side rods (see Rods)
  Situation, The 335§
  Spring Rigging, The equalization of, by J. McAllister 38*
  Steam, The future of the 274§
  Terminals (see Engine Terminals)
  Stoker fired, Test of, over three divisions (Erie railroad) 215
  Throttle rod stuffing box, Gustin-Bacon Mfg. Co. 720*
  Tire flanges, Sharp 70§
  Trailer box with lateral adjustment, J. E. Osmer (Ann Arbor railroad) 20*
  Treads for driving wheels, Straight vs. coned 145‡
  Valve, An improved throttle, by W. J. Knox (B. R. & P.) 216*
  Valve, Automatic exhaust pipe and blower, J. E. Osmer 468*
  Valve gear, Method for squaring Walschaert, by W. J. Dixon 189*
  Valve gear, Method of laying out Walschaert, by J. J. Jones 744*
  Valve gears, Maintain 70§
  Waste in operation as affected by design, Avoidable, by James Partington 673*
  Wheels (see Wheels)

Locomotives
  0-6-0, 0-8-0, 0-6-6-0, 2-4-4-0, 2-10-0, 2-6-2, 4-6-0 types, Tomsk railway 8*
  0-8-0, 4-6-2, 3-9-2 and 2-8-8-2 types for the Northern Pacific 679*
  2-8-0 type for the Western Maryland 419*
  2-8-2 type for the Nickel Plate 737*
  2-8-2 and 4-8-2 types for the Missouri Pacific 609*
  2-10-2 type, for the Southern Pacific 481*
  4-6-2 and 2-10-2 types, for the Southern Pacific 481*
  4-8-2 type, for C. R. I. & P. 147*
  Compounds, Are American roads prejudiced against, by W. G. Landon 276‡
  Design of large, The, by M. H. Haig, (A. S. M. E.) 277*
  Design and operation of present-day Necessity for improvement in the. by H. W. Snyder (A. S. M. E) 282
  DeWitt Clinton, The 553*
  Diesel engine on the Swedish Railways. 156*
  Diesel locomotives a possibility, Are 144§
  Mountain type, The New Haven 5‡
  Oil burning, Operating and maintaining 747
  Steam and electric, comparison of 292
  Three-cylinder, The 678

Loudenbeek, H. C., Uniform heat treatment of steel 309
Lubricant for hub liners, Joseph Dixon Crucible Co. 56
Lubricating air compressors, Properties of oils for 542
Lubrication, Grease, by T. J. Holmes 76
Lubrication of freight and passenger equipment, by M. J. O'Connor (N. Y. C.) 33
Lubricator, A positive mechanical journal, Hennessy Lubricator Co. 466*
Lubricator, Pneumatic crude oil flange, Hoofer Mfg. Co. 525*
Lumber, The conservation of 2§
Lyon Metallic Mfg. Co., Metal booth for timekeepers and foremen 406*
Lynn, Samuel, Repair and maintenance of steel freight cars 299

M

Machines, Overhaul the old 415§
Machinery, High production 535§
Machine tool needs, Prepare now for future 479§
Machine tool obsolescence 208§
Machine tool selection, The problem of, by R. S. Mennie 353

Machine Tools
  Boring and drilling machine, Baker Bros. 136*
  Boring, drilling and milling machine, Pawling & Harnischfeger 657*
  Boring machine, Heavy car wheel, Betts Machine Co. 653*
  Boring mill, High power vertical turning and, Colburn Machine Tool Co. 462*

* Illustrated article; § editorial; † short, non-illustrated article or note; ‡ communication.

Machine Tools—Continued

Brake shoe key taper rolling machine, Ajax Mfg. Co. 323*
Cutting-off tool with long cutting circumference, R. G. Smith Tool & Mfg. Co. 196*
Drill, A new post, Black & Decker Mfg. Co. 256*
Drill, Ball bearing heavy duty radial, Carlton Machine Tool Co. 386*
Drill for tank car work, Gantry, William K. Stamets 596*
Drill grinder, Improvements in twist, Wilmarth & Morman Co. 265*
Drill of novel design, Electric hammer, Chicago Pneumatic Tool Co. 263*
Drill, Radial drill stand and removable, Hisey-Wolf Machine Co. 201*
Drill, Self-oiling all geared gang, Barnes Drill Co. 406*
Drill, Twenty-one inch heavy duty upright, Fosdick Machine Tool Co. 395*
Drill with automatic switch, Portable electric, Wodack Electric Tool Corp. 132*
Drill with pistol grip, Portable electric, Cincinnati Electrical Tool Co. 720*
Drill with stationary head, Twenty-two inch, Production Machine Tool Co. 56*
Drilling machine with nut facing fixture, Edlund Machinery Co. 397*
Grinder and buffing machine, Electric, U. S. Electrical Mfg. Co. 390*
Grinder, Double annular ball bearing floor, Glow Electric Co. 394*
Grinder, eight-inch electric bench, Black & Decker Mfg. Co. 785*
Grinder for irregular parts, Internal, Landis Tool Co. 529*
Grinder, Heavy duty ball bearing, Marschke Mfg. Co. 261*
Grinder, Heavy duty motor driven face, Bridgeport Safety Emery Wheel Co. 126*
Grinder, Heavy duty reversing motor face, Springfield Mfg. Co. 390*
Grinder, Rotary piston pneumatic, Keller Pneumatic Tool Co. 408*
Grinder, Self-contained internal, Heald Machine Co. 200*
Grinder, Semi-automatic twist drill, Bellevue Industrial Furnace Co. 400*
Grinder, Small high duty surface, Diamond Machine Co. 193*
Grinder, Small sensitive vertical spindle surface, Abrasive Machine Tool Co. 198*
Grinder with pistol grip, Portable electric, Black & Decker Mfg. Co. 469*
Grinding and buffing machine, Combination, Cincinnati Electrical Tool Co. 266*
Grinding machine, Continuous feed disc, Gardner Machine Co. 59*
Grinding machine, Knee-type surface, Graham Mfg. Co. 717*
Grinding machine, Oscillating surface, Springfield Mfg. Co. 407*
Grinding machine, Power feed internal, Heald Machine Co. 60*
Grinding machine, Vertical-spindle surface, Pratt & Whitney Co. 715*
Lathe, A new 16-in. rapid production, Oliver Machinery Co. 264*
Lathe, Compact selective head engine, Lehmann Machine Co. 131*
Lathe, Cone pulley gap bed, Shepard Lathe Co. 408*
Lathe, Fifty-four inch tire turning, Manning, Maxwell & Moore 385*
Lathe, Geared head, Morris Machine Tool Co. 384*
Lathe, Heavy pattern, 90-in. driving wheel, William Sellers & Co. 521*
Lathe, 90-in. journal-turning, Niles-Bement-Pond Co. 591*
Lathe, High production double axle, Manning, Maxwell & Moore 382*
Lathe, Sixty-inch of exceptional power, Houston, Stanwood & Gamble Co. 464*
Lathe, The modern driving wheel 479§
Miller, Hollow spindle thread and form, Smalley-General Co. 383*
Milling machine, Cone drive plain, Ford-Smith Machine Co. 259*
Milling machine for medium heavy work, Plain, Kempsmith Mfg. Co. 57*
Milling machine, Heavy planer type, Becker Milling Machine Co. 388*
Milling machine in use in Germany, Three column frame 83*
Milling machine with rectangular overarm, Rockford Milling Machine Co. 393*
Planer designed for maximum service, New, G. A. Gray Co. 777*
Planer equipped with motor drive, Crank, Woodward & Powell Planer Co. 392*
Planer, Thirty-inch shoe and wedge, Cincinnati Planer Co. 129*
Planer, Thirty-two inch, Whitcomb-Blaisdell Machine Tool Co. 388*
Saw bench, Belt or motor driven variety, Oliver Machinery Co. 57*
Saw blade with fine and coarse teeth, Hack, Peerless Machine Co. 399*
Saw for heavy duty, Cold metal, Earle Gear & Machine Co. 396*

Machine Tools—Continued

Saw, High Speed friction metal cutting, Joseph T. Ryerson & Son 55*
Shaper, Cone or single pulley driven, Bertschy Engineering Co. 398*
Shaper, Heavy duty traverse head, Manning, Maxwell & Moore 325*

Machine tools, Comment on the purchase of, by F. G. Lister 736§
Machine tools, Cost of operating obsolete, by R. S. Mennie 551
Machine tools, Location and grouping of 536§
Machine tools, Suggestions on the purchase of 606§
MacCleod, Norman, An auxiliary car coupler 564*
MacCleod, Norman, Feed valve testing device 644*
MacCleod, Norman, Overcoming an objectionable column where crane service was desired 713*
MacCleod, Norman, Pneumatic grease gun 455*
MacCleod, Norman, Sifter for renovating old sponging waste 348*
MacCleod, Norman, Soft packing cutter 320*
Main rod angularity, Locomotive, by William Ulrich 519*
Main rod repairs 537§
Main rod repairs, Speeding up locomotive, by M. H. Williams 543*
Maintaining oil burning locomotives, Operating and 747
Maintenance, An incentive to provide for 143§
Maintenance cost of valve chamber bushings and packing, by Frank Roberts 513*
Maintenance of steel freight cars, Repair and, by Samuel Lynn 299
Management in railroad shops, by J. C. Clark 6‡
Management of a locomotive repair shop, The, by Col. H. E. O'Brien 42*
Management, The functions of 285
Management: Pencil repairs and inexperienced foremen, by A. F. Barbolt 71‡
Manning, Maxwell & Moore, Fifty-four inch tire turning lathe 385*
Manning, Maxwell & Moore, Heavy duty traverse head shaper 325*
Manning, Maxwell & Moore, High production double axle lathe 382*
Marschke Mfg. Co., Heavy duty ball bearing dry grinder 261*
Martin, Jacob, Planer type milling machine makes record (C. C. C. & St. L.) 766*
Master Boiler Makers' committee reports 711
Material-handling devices and shop layout 537§
McAllister, J., The equalization of spring rigging 38*
McAllister, J., Fuel economy by accurate valve setting 311*
McCrosky Tool Corp., Easily applied self-centering steady rest 54*
McCrosky Tool Corp., Floating holder corrects spindle misalinement 530*
Mechanical department, The present situation in the 334§
Men, Fundamental principles of handling 60†
Mennie, R. S., Cost of operating obsolete machine tools 551
Mennie, R. S., The problem of machine tool selection 353
Messimer, N. B., An efficient car straightening frame (N. Y. C.) 31*
Metal surfaces, Wire brush for cleaning, Ingersoll-Rand Co. 387*
Metal & Thermit Corp., Molding material 594
Metals, Progressive failure or fatigue of, under repeated stress, by H. F. Moore 240
Metallurgy of high speed steel, The, by D. M. Giltinan 709*
Micrometer, Expanding internal thread, John Bath & Co. 463*
Micrometer of unusual design, Internal, John Bath & Co. 326*
Midland Railway (England), Fractures in boiler tubes 356
Milk, Handling, in specially constructed tank cars, Baltimore & Ohio 763*
Miller, E. A., An easily made babbitting furnace 248*
Miller, E. A., Driving box chuck 250*
Miller, E. A., Gage for calipering driving wheels and tires 242*
Miller, E. A., Piston rod centering sleeve 252*
Miller, E. A., Stool for supporting front end of boiler 48*
Miller, E. A., Thawing frozen hopper cars 638*
Miller, E. A., Three locomotive shop devices 702*
Miller, E. A., Two boiler shop tools 765*
Milling attachment, Easily applied high speed, Brown & Sharpe Mfg. Co. 51*
Milling machine (see Machine Tools)
Milling machine, The planer type 733§
Milling machine makes record, Planer type, by Jacob Martin (C. C. C. & St. L.) 766*
Milling machines, Constant speed drive for, Oesterlein Machine Co. 716*
Milling machines, Motor drive for, Clark-Mesker Co. 134*
Minich Railway Appliance Corp., Safety hand brake equipment 472*
Missouri Pacific, 2-8-2 and 4-8-2 type locomotives for the 609*
Mitchell, John, selecting Foremen 209‡
Mitchell, John, Suggestions for improvements in locomotives 434
Modern Tool Co., Self-opening and adjustable die heads 398*
Molding material, Metal & Thermit Corp. 594
Mono Corp. of America, Flue gas analyzer 195*
Monroe, Roy G., The use of gas in railroad shops 458
Moore, H. F., Progressive failure or fatigue of metals under repeated stress 240
Morris Machine Tool Co., Geared head lathe 384*
Mortiser, Direct motor drive applied to, Oliver Machinery Co. 723*
Morton Mfg. Co., Special railroad draw-cut shaper attachments 321*
Motor drive for internal grinder, New Heald Machine Co. 53*
Muhlfeld, J. E., Causes of the present bad order situation 738
Mullinix, S. W., A visit to a prominent mid-west railroad shop (C. R. I. & P.) 365*
Murphy, H. M. P., Designing brake heads for uniform shoe wear 107*
Murphy, J. W., A welded locomotive tender tank (Boston & Albany) 550*
Murray, W. S., Superpower survey 739*

N

National Acme Co., Improved automatic collapsing tap 54*
Nelson Tool & Machine Co., Angle plate with second face and T-slot 129*
New Haven Mountain type locomotives, The, by J. C. Hassett 5‡
New York Blue Print Paper Co., Precise parallel ruling attachment 197*
New York Central, An efficient car straightening frame, N. B. Messimer 31*
New York Central, Container car in express service on the 171*
New York Central, Lubrication of freight and passenger equipment, by M. J. O'Connor 33
New York Central: The DeWitt Clinton 553*
New York, Chicago & St. Louis, 2-8-2 type locomotives for the 737*
New York, New Haven & Hartford, Repairing steel cars in a remodeled roundhouse 751*
Niagara Machine & Tool Works, Power sheet metal squaring shear 594*
Nickel Plate, 2-8-2 type locomotives for the 737*
Niles-Bement-Pond Co., 90-in. journal-turning lathe 591*
Nordling and Bengtzon, New type of spiral boiler tubes developed in Sweden 783*
Norfolk & Western 100-ton coal cars, by John A. Pilcher 293*, 367*
Norfolk & Western, Hydraulic rod bushing press, by J. H. Hahn 776*
Norfolk & Western, Power punches and dies 50*
Northern Pacific, New locomotives for the 679*
Norton, Charles H., A few points on grinding 514
Norton Mfg. Co., Portable rivet heating forge 200*
Norton Mfg. Co., Portable safety vacuum torch 404*
Nozzle, Automatic variable exhaust, by Clarence Roberts 494*
Nye, C., A T-square attachment 370*

O

O'Brien, A. F., Saving money in car repairs 298
O'Brien, Col. H. E., An English locomotive repair system (Lancashire & Yorkshire) 119*
O'Brien, Col. H. E., Limit gages and progressive sizes 177
O'Brien, Col. H. E., The management of a locomotive repair shop 42*
O'Connor, M. J., Lubrication of freight and passenger equipment (N. Y. C.) 33
Oesterlein Machine Co., Constant speed drive for milling machines 716*
Oil burning locomotives, Operating and maintaining 747
Oilgear Co., Oil-Pressure transmission and feed control 659*
Oil installations, British views on fuel 764
Oil-pressure transmission and feed control, Oilgear Co. 659*
Oils for lubricating air compressors, Properties of 542
Oliver Machinery Co., Direct motor drive applied to mortiser 723*
Oliver Machinery Co., Gear pattern cutting attachment 593*
Oliver Machinery Co., A new 16-in. rapid production lathe 264*
Oliver Machinery Co., Belt or motor driven variety saw bench 57*
Oliver Machinery Co., Belt sanding and polishing machine 597*
Oliver Machinery Co., Overhead swing cut-off saw table 402*
Oliver Machinery Co., Wood turning lathe of unusual length 134*
Operating and maintaining oil burning locomotives 747
Operation, Vitalizing locomotives to improve, by George M. Basford 357*

* Illustrated article; § editorial; † short, non-illustrated article or note; ‡ communication.

Osbourne, F., Staybolt and stud driver and remover 118*
Osmer, J. E., Automatic exhaust pipe and blower valve 468*
Osmer, J. E., Trailer box with lateral adjustment (Ann Arbor railroad).......... 20*
Otto, Henry, Heat treating steel in railway shops 47*
Oxweld Acetylene Co., Wrecked shear reclaimed by welding.......... 241*
Oxy-acetylene blowpipes, Tests of.......... 449
Oxy-acetylene cutting tests, by John C. Eichner 713
Oxy-acetylene cutting, Table for, J. J. Albert 708*

P

Pack, A. G., A decision that may be misconstrued .... 336‡
Packing, Combination fibre and metallic, Pilot Packing Co.......... 660*
Packing cutter, Soft, by Norman MacLeod. 320*
Packing for general use, Fibrous metallic, General Engineering Accessories.......... 263
Packing ring grooves, Device for slightly closing 122*
Paight, Joseph T., Welding cylinders with Tobin bronze.......... 374*
Paint spraying locomotive front ends.......... 124*
Paris-Orleans apprentice work organized.. 313*
Parker Co., Charles, Convenient and durable bench vises 400*
Partington, James, Avoidable waste in locomotive operation as affected by design... 673*
Patch plate made of old air signal valve part, Emergency 46*
Pawling & Harnischfeger, Boring, drilling and milling machine.......... 657*
Pearce, E. S., The automatic control of locomotive cut-off.......... 488*
Peerless Machine Co., Hack saw blade with fine and coarse teeth.......... 399*
Phelps, J. Robert, Four efficient machine shop devices (A. T. & S. F.).......... 317*
Piecework the issue, Is.......... 536§
Piecework ban, Labor Board lifts.......... 701
Piecework, The reintroduction of.......... 671§
Pilcher, John A., New Norfolk & Western 100-ton coal cars..........293*, 367*
Pilot Packing Co., Combination fibre and metallic packing.......... 660*
Pins and bushings, Advantages of standard motion .... 2§
Pins and bushings, Standard valve, motion, by M. H. Williams.......... 39*
Piston rod and throttle packing, Increasing the efficiency of, by Frank Roberts.......... 520*
Piston rod centering sleeve, by E. A. Miller 252*
Pistons, Device for removing air compressor, by J. H. Hahn.......... 510*
Pittsburg & Shawmut, Gasoline motor driven passenger car, Bowen Motor Railways Corp. 697
Planer (see Machine tools)
Planer type milling machine, The.......... 733§
Planer type milling machine makes record, by Jacob Martin (C. C. C. & St. L.).... 766*
Plans and specifications for postal cars and fixtures, New 101*
Plant, L. G., The locomotive terminal an operating factor 15*
Plates, Harter circulating.......... 609
Pneumatic tools, Hose coupling for, Ingersoll-Rand Co. 55*
Poland, Container cars in use in, S. Rodowicz 689*
Polishing machine, Belt sanding and, Oliver Machinery Co.......... 597*
Portevin, Albert M., Characteristic heat treatment curves 775*
Poultney, E. C., The comparison of dimensions and proportions of British locomotives 539, 621*
Power and light for railroad shops, Electric, by J. E. Gardner.......... 515
Power house, Don't neglect the.......... 735§
Power plants, Reducing the fuel consumption of, by William N. Allman..........88*, 154
Power reverse gear, Precision, Franklin Railway Supply Co.......... 470*
Pratt & Whitney Co., Vertical-spindle surface grinding machine.......... 715*
Precision & Thread Grinder Mfg. Co., Lathe lead screw variator device.......... 403*
Prentice, Harold C., The roundhouse up to date 337*
Press, Special hydraulic driving wheel, Hydraulic Press Mfg. Co.......... 598*
Press with sectional dies, Plate, Houston, Stanwood & Gamble Co.......... 264*
Prices for labor and material, Report on (Div. V—Mech.) 572
Production Machine Tool Co., Twenty-two inch drill with stationary head.......... 56*
Productive efficiency, Wages, cost of living and .... 416§
Pulley grinding attachment, Diamond Machine Co. 324*
Pull jack, Straightening car ends with a, by A. H. Anderson.......... 239*
Pulverized fuel, Report of committee on (Fuel convention) 424
Pump, Efficient rotary piston type, St. Louis Pump & Equipment Co.......... 135*
Pump for air test rack, High pressure, by C. E. Yocum 118*
Pump for cooling compounds, Centrifugal, Ross Mfg. Co.......... 197*
Punches and dies, Power.......... 49*
Pyrometer, Cold junction compensated, Brown Instrument Co.......... 595*
Pyrometers promote locomotive efficiency.. 433*

Q

Queen City Machine Tool Co., Two-unit feeding device for shapers.......... 128*

Questions and Answers:
  Cylinder center above center line of axle, Location of.......... 93
  Speed of trains, Finding the.......... 93

R

Radiagraph, The.......... 705*
Railroad administration draft gear tests 173, 229, 435*, 497*
Railroad organizations, Getting better results from, by George M. Basford.......... 151
Railway situation, The present, by Samuel O. Dunn (Fuel convention).......... 423
Rail washer, J. M. Riddle.......... 465*
Rawlplug Co., Making screws hold in any material 529*
Ready Tool Co., A new spring threading tool 262*
Reaming reversing valve bushings, by Charles W. Schane 184*
Reaming tube sheet holes, by George Brexton 318*
Reclaiming bent I-beams, by Wesley J. Wiggin 704*
Reclaiming rolls, New model scrap, Ajax Mfg. Co. 383*
Reclamation project, A profitable railroad, C. C. C. & St. L.......... 185*
Reclamation work on the Virginian, by F. S. Tinder 509*
Recording thermometers, Long distance, Brown Instrument Co.......... 471*
Repairing steel cars in a remodeled roundhouse, N. Y., N. H. & H.......... 751*
Repair and maintenance of steel freight cars, by Samuel Lynn.......... 299
Repair card, Supplying additional information on building.......... 753
Repair parts, Manufacturing standard locomotive, by M. H. Williams..........451*, 511*
Repair system, An English locomotive, by Col. H. E. O'Brien (Lancashire & Yorkshire) 119*
Repair work must be done, More.......... 334§
Repairs, A brighter outlook for car.......... 607§
Repairs, Effect on cost of, of changes in the percentage of freight cars at home.......... 170
Repairs for freight cars, Periodical, by F. S. Gallagher 24
Repairs, Main rod .... 537§
Repairs, Make car owners' responsibility complete, by C. J. Wymer.......... 695
Repairs, Roundhouse vs. back shop.......... 415§
Repairs, Saving money in car, by A. F. O'Brien 298
Repairs, Scheduling car, increases shop output, by E. T. Spidy.......... 349*
Repairs, Speeding up locomotive main rod, by M. H. Williams.......... 543*
Reverse gear, Precision power, Franklin Railway Supply Co.......... 470*
Reverse gear, The throttle vs. the.......... 478§
Rich, F. D., Belt service and length of life.. 37*
Richey, G. H., Cost of air vs. steam for operating hammers 450
Riddle, J. M., Rail washer.......... 465*
Riehle Bros. Testing Machine Co., Combination hardness testing machine.......... 656*
Rink, G. W., Modernizing existing locomotive terminals 73*
Roberts, Clarence, Automatic variable exhaust nozzle 494*
Roberts, Clarence, The advantages of the exhaust steam injector.......... 290*
Roberts, Frank, Curing troublesome frame failures 252*
Roberts, Frank, Increasing the efficiency of piston rod and throttle packing.......... 520*
Roberts, Frank, Reducing maintenance cost of valve chamber bushings and packing.. 513*
Rockford Milling Machine Co., Milling machine with rectangular overarm.......... 393*
Rod bushing press, Hydraulic, by J. H. Hahn (Norfolk & Western).......... 776*
Rod design, A new, Erie railroad.......... 218*
Rods and drawbars, holder for side, by M. C. Whelan 461*
Rods, Successful methods used in repairing side, by M. H. Williams 639*
Rodowicz, S., Container cars in use in Poland 689*
Rogatchoff Co., Recent improvements in adjustable crosshead 785*
Rogers, John D., Drop pits at terminals on the South African railways.......... 677*
Ross Mfg. Co., Centrifugal pump for cooling compounds 197*
Roundhouse, Repairing steel cars in a remodeled, N. Y., N. H. & H.......... 751*
Roundhouse up to date, The, by Harold C. Prentice 337*
Routing systems for car shops, Scheduling and, by Henry Gardner.......... 502
Roys, F. W., The effect of relative humidity on leather belting.......... 190*
Rules of interchange, Car inspectors propose change in..........233, 304, 375, 441
Rules of interchange, Make car owners' responsibility complete, by C. J. Wymer.... 695
Rules for preparing work and making welds, by G. M. Calmbach.......... 772*
Ruling attachment, Precise parallel, New York Blue Print Paper Co.......... 197*
Running board bracket. Easily detachable, C. B. Baker 722*
Rusting of steel containing copper, The.... 291
Rusting of steel containing copper, by D. M. Buck .... 538‡
Ryerson & Son, Joseph T., High speed friction metal cutting saw.......... 55*

S

Sackett, H. S., The use of wood in freight car construction 105
Safe ends on locomotive boiler tubes, Methods of welding (Master Boiler Makers' Association) 711
Safety code for compressed air machinery, American Society of Safety Engineers.... 712
Safety of passengers in steel railway cars, The. by Frank M. Brinckerhoff.......... 223*
St. Louis Pump & Equipment Co., Efficient rotary piston type pump.......... 135*
Sand blasting, Portable device for, Transportation Engineering Corp.......... 392*
Sanding and polishing machine, Belt, Oliver Machinery Co. 597*
Savage, H. D., The use of powdered fuel under steam boilers.......... 589
Saw, Metal cutting (see Machine Tools)
Saw table, Overhead swing cut-off, Oliver Machinery Co.......... 402*
Scarritt Car Seat & Mfg. Co., New coach seat 467*
Schane, Charles W., Reaming reversing valve bushings 184*
Schaphorst, W. F., Chart gives power of belts 687*
Schaphorst, W. F., The cost of boiler scale.. 292*
Scheduling and routing systems for car shops, by Henry Gardner.......... 502
Scheduling car repairs increases shop output, by E. T. Spidy.......... 349*
Scheduling system, A locomotive repair shop, by Grant Gibson 243*
Schioler, Paul, The requirements for a modern car repair shop.......... 759*
Schlafge, William, A new rod design (Erie) 218*
Schneider, Heinrich, The Diesel locomotive.. 156*
Scrap reclaiming rolls, New model, Ajax Mfg. Co. 383*
Screw variator device, Lathe lead, Precision & Thread Grinder Mfg. Co.......... 403*
Screws hold in any material, Making, Rawlplug Co. 529*
Seat, New coach, Scarritt Car Seat & Mfg. Co. 467*
Seat, Single pedestal swivel type car, Frank Smolar 125*
Sedwick, T. D., Why some fusion welds fail 114*
Selleck, Theodore G., The effect of temperature in case-hardening.......... 648*
Sellers & Co., William, Heavy pattern 90-in. driving wheel lathe.......... 521*
Shamberger, J. P., A system for numbering shop machinery.......... 514
Shaper (see Machine Tools).
Shaper attachments, Special railroad draw-cut, Morton Mfg. Co.......... 321*
Shapers, Two-unit feeding device for, Queen City Machine Tool Co.......... 128*
Sharon Pressed Steel Co., Heavy duty trailer for concentrated loads.......... 721*
Shear of large capacity, Rotary turret, Southwark Foundry & Machine Co.......... 655*
Shear, Power sheet metal squaring, Niagara Machine & Tool Works.......... 594*
Shear reclaimed by welding, Wrecked, Oxweld Acetylene Co.......... 241*
Sheds, Why build firing-up.......... 145§
Shepard Lathe Co., Cone pulley gap bed lathe 408*
Shepard, Louis A., Some facts regarding bearings 312

Shop Kinks

  Air compressor pistons, Device for removing, by J. H. Hahn.......... 510*
  Air compressor repair, Erie Railroad.... 191*
  Babbitting furnace, An easily made, by E. A. Miller.......... 248*
  Bearings, Fixture for turning lift shaft, B. R. & P.......... 180*

* Illustrated article; § editorial; † short, non-illustrated article or note; ‡ communication.

Shop Kinks—Continued
Belt, Method of squaring uneven, by F. D. Rich 37*
Boilers, Fixture for rolling, B. R. & P. 180*
Bolt puller, Frame 340*
Boring air compressor cylinders, B. R. & P. 180*
Cab apron holder, by E. A. Miller 702*
Cast iron cutting 310
Chipping screen, An improved, by A. G. Johnson 518*
Chuck for holding hose nuts, by J. M. Cairns 181*
Crosshead babbitting devices 187*
Cutter for facing off welded tube ends, by E. A. Miller 765*
Cutting, Inclining the torch when 706*
Cylinder cap of air compressor governor, Repairing 48*
Device for grooving driving boxes 192*
Device for spreading locomotive frames, Yazoo & Mississippi Valley 380*
Device for turning bevels on a boring mill (A. T. & S. F.) 317*
Drill, making a, live up to its reputation, by H. Wills 249*
Driving boxes, Boring, B. R. & P. 179*
Extension table for milling machine (A. T. & S. F.) 318*
Feed valve testing device, by Norman MacCleod 644*
Flue cutter, Liberty, C. R. I. & P. 184*
Formers for bending end sill for standard motor truck, by Wesley J. Wiggin 703*
Frame failures, Curing troublesome, by Frank Roberts 252*
Gage, Driving box 178*
Gage for calipering driving wheels and tires, by E. A. Miller 242*
Gage for detecting worn arch tubes, by E. A. Miller 765*
Gages facilitate repairing valves in air brake department, Standard, by F. A. Skinner 49*
Grease gun, pneumatic, by Norman MacCleod 455*
Guard for emery wheel dresser, by E. A. Miller 702*
Hardening hammer die blocks, by R. B. Kerr 252
Holder for side rods and drawbars, by M. C. Whelan 461*
Hydraulic rod bushing press, by J. H. Hahn (Norfolk & Western) 776*
Jig for machining reversing valve bushing seats, by J. H. Hahn 553*
Jig for use in drilling grease plug holes by E. A. Miller 702*
Ladder for car shops, Step, by Austin G. Johnson (Duluth & Iron Range) 590*
Machining driving boxes 310*
Packing Cutter, Soft, by Norman MacLeod 320*
Packing ring grooves, Device for slightly closing 122*
Patch plate made of old air signal valve part, Emergency 46*
Piston rod centering sleeve, by E. A. Miller 252*
Pump for air test rack, High pressure, by C. E. Yocum 118*
Reaming reversing valve bushings, by Charles W. Schane 184*
Reaming tube sheet holes, by George Brexton 318*
Reclamation of a badly distorted tender frame 352*
Reclaiming bent I-beams, by Wesley J. Wiggin 704*
Rods, Successful methods used in repairing side, by M. H. Williams 639*
Screen, Safety folding, B. R. & P. 180*
Sifter for renovating old sponging waste, by Norman MacCleod 348*
Slotter for machining crown brasses, B. R. & P. 179*
Square attachment, Combination (A. T. & S. F.) 317*
Staybolt and stud driver and remover, by F. Osbourne 118*
Stool for supporting front end of boiler, by E. A. Miller 48*
Swinging arm for removing lathe chucks (A. T. & S. F.) 317*
Tapping radial holes in boiler shells 248*
Tool-holders for use with high-speed steel tool bits, Wheel lathe 651*
Tool rack with sheet iron drawer, B. R. & P. 180*
Truck for driving boxes, by J. H. Hahn 518*
Truck for handling jacket iron, by A. G. Johnson 118*
T-square attachment, A, by C. Nye 370*
Valve seat refacing tool, Emergency, by John Flinner 184*
Washout plugs, Method of machining, B. R. & P. 179*
Welding a needle beam, by Wesley J. Wiggin 704*
Welding, Locomotive cylinder, Wabash Ry. 191*

Shop layout, Material-handling devices and 537§
Shop practice at Du Bois, Notes on general, by George W. Armstrong (B. R. & P.) 179*
Shop, A visit to a prominent mid-west railroad, by S. W. Mullinix (C. R. I. & P.) 365*
Shop devices, Three locomotive, by E. A. Miller 702*
Shop devices, Four efficient machine, by J. Robert Phelps (A. T. & S. F.) 317*
Shop discipline, A system of progressive, by Grant Gibson 319*
Shop, Improving a, by a limited expenditure, by G. M. Lawrence 355*
Shop layout, Overcoming an objectionable column where crane service was desired, by Norman McCleod 713*
Shop machinery, A system for numbering, by J. P. Shamberger 514
Shop men, What is the other fellow doing? 208§
Shop output, Scheduling car repairs increases, by E. T. Spidy 349*
Shop practice at Du Bois, Notes on general, by George W. Armstrong (B. R. & P.) 179*
Shop, Revivifying the railroad, by G. W. Armstrong 341*
Shop, The management of a locomotive repair, by Col. H. E. O'Brien 42*
Shop, The requirements for a modern car repair, by H. H. Dickinson and Paul Schioler 759*
Shop, The railroad shop vs. the contract 631
Shop scheduling system, A locomotive repair, by Grant Gibson 243*
Shop work, Interesting examples of blacksmith, by Wesley J. Wiggin 703*
Shop work, What constitutes the cost of 606§
Shops are the neck of the bottle 335§
Shops, Management in railroad, by J. C. Clark 6‡
Shops needed, Centralized production 417§
Shops, The Krasnoyarsk, Tomsk railway 11*
Shovel for molders and locomotive firemen, Lightweight, Conneaut Shovel Co. 467*
Side rods (see Rods).
Sifter for renovating old sponging waste, by Norman MacLeod 348*
Sillcox, L. K., Widening the outlook of the local car foreman (C. M. & St. P.) 371*
Skinner, F. A., Standard gages facilitate repairing valves in air brake department 49*
Smalley-General Co., Hollow spindle thread and form miller 383*
Smith, C. B., Increasing the capacity of old locomotives 84
Smith Tool & Mfg. Co., R. G., Cutting-off tool with long cutting circumference 196*
Smclar, Frank, Single pedestal swivel type car seat 125*
Snyder, H. W., Necessity for improvement in the design and operation of present-day locomotives (A. S. M. E.) 282
South African railways, Drop pits at terminals on the, by John D. Rogers 677*
Southern Pacific, Long stroke cylinder tests on 613*
Southern Pacific, New Pacific and Santa Fe locomotives for the 481*
Southwark Foundry & Machine Co., Rotary turret shear of large capacity 655*
Southwark Foundry & Machine Co., Universal flue welding machine 391*
Specifications and tests for materials, Report on (Div. IV—Mech.) 565
Speed and feed recording device, O. Zernickow 407*
Spidy, E. T., Scheduling car repairs increases shop output 349*
Sponging waste, Sifter for renovating old, by Norman MacLeod 348*
Spring banding machine for small shops 187*
Springfield Mfg. Co., Heavy duty reversing motor face grinder 390*
Springfield Mfg. Co., Oscillating surface grinding machine 407*
Spring rigging, The equalization of, by J. McAllister 38*
Sprinkler, Safety locomotive cold water, George Dittman 196*
Stacks, D. H., Grinding sparks as a measure of carbon content (Steel Treaters' convention) 646
Stamets, William K., Gantry drill for tank car work 596*
Standard Semi-Steel Foundry Co., Bronze-faced driving box shoes and wedges 719*
Starter, Rigidly constructed auto-transformer, Cutler-Hammer Mfg. Co. 261*
Staybolt and stud driver and remover, by F. Osbourne 118*
Steady rest, Easily applied self-centering, McCrosky Tool Corp. 54*
Steam hammer repair, by W. E. Gibbs 558*
Steam pressure in locomotive service, Higher 1§
Steel containing copper, The rusting of 291
Steel containing copper, Rusting of, by D. M. Buck 538‡
Steel, Heat treating, in railway shops, by Henry Otto 47*
Steel, Physical tests of high speed, by A. H. d'Arcambal (Steel Treaters' convention) 646
Steel specifications (American Society for Testing Materials) 493
Steel, The efficacy of annealing overstrained by I. H. Condrey (Steel Treaters' Convention) 647
Steel, The metallurgy of high speed, by D. M. Giltinan 709*
Steels, The toughness of high speed, as affected by their heat treatment, by M. A. Grossman (Steel Treaters' convention) 646
Steel Treaters' Society convention proceedings 645
Steel, Uniform heat treatment of, by H. C. Loudenbeck 309
Stewart, J. C., Means of preventing hot boxes 440
Stuebing, A. F., Economic advantages of large freight locomotives 346
Sullivan Machinery Co., Air-operated hoist of novel design 527*
Sulphuric acid tank cars of 70 tons capacity, General Chemical Co. 95*
Superpower survey 739*
Suspension for tractors, Duplex compensating, Baker, R. & L. Co. 257*
Sweden, New type of spiral boiler tubes developed in, Nordling and Bengtzon 783*
Swedish railways, Diesel electric cars and engines on the 156*
Symington Co., T. H., Test plant of the 435

T

Table for milling machines, Rotary, Clark-Mesker Co. 266*
Taft, R. C., Bolster attachments for metal draft arm 130*
Tap, Improved automatic collapsing, National Acme Co. 54*
Tapping radial holes in boiler shells 248*
Taylor Welder Co., Spot welding machine of new design 405*
Tender frame, Reclamation of a badly distorted 352*
Tender tank, A welded locomotive, by J. W. Murphy (Boston & Albany) 550*
Tests on Southern Pacific, Long stroke cylinder 613*
Thermalloy for high temperature castings, Electro Alloys Co. 654*
Thermit, Mix thoroughly before using 564
Thermometers, Long distance recording, Brown Instrument Co. 471*
Thomas E., Car wheel grinding data desired 736§
Thornley & Co., F. C., Coalometer 58*
Threader, Three-quarter inch double spindle, Geometric Tool Co. 402*
Threading machines, Single and double spindle, Eastern Machine Screw Corp. 394*
Threading tool, A new spring, Ready Tool Co. 262*
Throttle packing, Increasing the efficiency of piston rod and, by Frank Roberts 520*
Throttle rod stuffing box, Locomotive Gustin-Bacon Mfg. Co. 720*
Throttle vs. the reverse gear, The 478§
Tinder, F. S., Reclamation work on the Virginian 509*
Tobin bronze, Welding cylinders with, by Joseph T. Paight 374*
Tomsk railway, 0-6-0, 0-8-0, 0-6-6-0, 2-4-4-0, 2-10-0, 2-6-2, 4-6-0 type locomotives 8*
Tomsk railway, Hand or motor operated locomotive hoist used on the 12*
Tomsk railway, Mechanical equipment on the, by James Grant 7*
Tomsk railway, The Krasnoyarsk shops 11*
Tool-holders for use with high-speed steel tool bits, Wheel lathe 651*
Tool selection, The problem of machine, by R. S. Mennie 353
Tools for machinists and toolmakers, Improved, Brown & Sharpe Mfg. Co. 389*
Tools, Manufacture of standard small 670§
Tools, Two boiler shop, by E. A. Miller 765*
Torch, Portable safety vacuum, Norton Mfg. Co. 404*
Tractors, Duplex compensating suspension for, Baker, R. & L. Co. 257*
Trailer for concentrated loads, Heavy duty, Sharon Pressed Steel Co. 721*
Train brake and signal equipment, Report on (Div. V—Mech.) 588*
Training vs. apprenticeship, Specialized 734§
Transportation Engineering Corp., Portable device for sand blasting 392*
Traveling Engineers' Association, Proceedings of informal meeting of 614
Trolley system, Short-turn overhead, Whiting Corp. 597*
Treads for driving wheels, Straight vs. coned 145‡
Trip levers for die heads, Redesigned, Eastern Machine Screw Corp. 263*
Truck equipped with carrying ram, Electric, Baker, R. & L. Co. 391*
Truck equipped with crane, Storage battery, Yale & Towne Mfg. Co. 472*
Truck for car repairs, Emergency, by E. A. Austin 228*
Truck for driving boxes, by J. H. Hahn 518*
Truck for freight cars, Lamont six-wheel, American Steel Foundries 254*
Truck for handling jacket iron, by A. G. Johnson 118*

* Illustrated article; § editorial; † short, non-illustrated article or note; ‡ communication.

Truck, Improved electric self-loading, Cowan Truck Co. 401*
Truck, one hundred ton locomotive shop, Whiting Corp. 780*
Truck, Self-loading type electric, Cowan Truck Co. 52*
Truck Six-wheel freight car, Buckeye Steel Castings Co. 522*
T-square attachment, A, by C. Nye 370*
Tube safe end with square shoulder, Coleman Boiler Appliance Co. 127*, 266
Tubes and combustion chambers, Length of 734§
Tubes developed in Sweden, New type of spiral boilers, Nordlin and Bengtzon 783*
Tubes, Fractures in boiler, Midland Railway (England) 356
Turning and boring mill, High power vertical, Colburn Machine Tool Co. 462*
Turntable indicating device, by M. A. Rouysov 688*

U

Uehling Instrument Co., Redesigned carbon dioxide recorders 133
Ulrich, William, Locomotive main rod angularity 519*
Ulrich, William, A short cut in squaring locomotive valves 123*
Union Pacific, Fruit express refrigerator cars 25*
Union Railway, Fatal gasoline explosion at Memphis 162
U. S. Electrical Mfg. Co., Electric grinder and buffing machine 390*
Universal Boring Machine Co., A new precision machine alining level 660*
Universal Car & Hose Coupler Co., A combined car coupler and hose connector 699*

V

Valve, An improved locomotive throttle, by W. J. Knox (B. R. & P.) 216*
Valve, Automatic exhaust pipe and blower, I. E. Osmer 468*
Valve bushing seats, Jig for machining reversing, by J. H. Hahn 553*
Valve chamber bushings and packing, by Frank Roberts 513*
Valve for liquid fuels, Regulating, Bailey-Lewis 194*
Valve gear, Method for squaring Walschaert, by W. J. Dixon 189*
Valve gear, Method of laying out Walschaert, by J. J. Jones 744*
Valve gears, Maintain locomotive 70§
Valve, New design of pressure seated, Cleveland Pneumatic Tool Co. 403*
Valve port, A surgical operation performed on a locomotive, by M. R. Feeley (D. L. & W.) 508*
Valve seat refacing tool, Emergency, by John Flinner 184*
Valve setting, Fuel economy by accurate, by J. McAllister 311*
Valve setting, Save time in 208§
Valve setting: The importance of checking cut-offs 274§
Valves, A short cut in squaring locomotive, by William Ulrich 123*
Valves, Automatic, non-return, Golden-Anderson Valve Specialty Co. 258*
Virginian railway, Demonstration of double-capacity brake 428*
Virginian railway 120-ton coal cars 163*, 228
Virginian railway, Reclamation work on the, by F. S. Tinder 509*
Vises, Adjustable divided machine, O. Zernickow 593*
Vises, Convenient and durable bench, Charles Parker Co. 400*
Volz, Howard, Railroad shop turret lathe practice 111*

W

Wabash Railway, Locomotive cylinder welding 191*

Wages

Are wage reductions necessary? 207§
Boards of adjustment to be abolished 17
Cost of living and productive efficiency 416§
Labor Board announces general reduction 379
Simple common sense 273§
Some prospect of improvement 334§
Starting over with a clean slate 334§

Walschaert valve gear, Method for squaring, by W. J. Dixon 189*
Walschaert valve gear, Method of laying out, by J. J. Jones 744*
Warner & Swasey Co., Clutch tap and die holder of simple design 526*
Wayne Tool Mfg. Co., Chuck for use with broken twist drills 718*
Weber, John Ph., Air hose coupling of simple design (A. T. & S. F.) 404*
Wedge, feed water heater and booster, Self-adjusting (Traveling Engineers' meeting) 616
Weighing plant of large capacity, Locomotive, by Carl C. Bailey 749*
Welding a needle beam, by Wesley J. Wiggin 704*
Welding cylinders with Tobin bronze, by Joseph T. Paight 374*
Welding development, Next step in 70§
Welding for repairing cast iron, Limitations of Thermit 38
Welding in railroad shops, Electric arc, by A. M. Candy 456*
Welding locomotive cylinders, by C. E. Farley 247*
Welding, Locomotive cylinder, Wabash Ry. 191*
Welding machine of new design, Spot, Taylor Welder Co. 405*
Welding machine, Universal flue, Southwark Foundry & Machine Co. 391*
Welding practice, Standards of railroad shop, by G. M. Calmbach 772*
Welding safe ends on locomotive boiler tubes, Methods of (Master Boiler Makers' Assn.) 711
Welding sets for medium and heavy duty, General Electric Co. 779*
Welding, Wrecked shear reclaimed by, Oxweld Acetylene Co. 241*
Welds fail, Why some fusion, by T. D. Sedwick 114*
Western Maryland, Consolidation locomotives for the 419*
Westinghouse Air Brake Co., Double-capacity brake 428*
Wheel grinding data desired, Car, by E. Thomas 736§
Wheel loads, Measuring locomotive and car; Holz & Co. 722*
Wheels and tires, Gage for calipering driving, by E. A. Miller 242*
Wheels, Chemical limits specified for iron car 477§
Wheels, Chilled cast-iron car (American Society for Testing Materials) 493
Wheels, Equalization of weights on locomotive 145§
Wheels, Grinding chilled cast iron car, A. T. & S. F. 181
Wheels, Some failures of chilled-iron car, by H. J. Force 505
Whelan, M. C., Holder for side rods and drawbars 461*
Whitcomb-Blaisdell Machine Tool Co., Thirty-two Inch planer 388*
Whiting Corp., Helical worm geared crane ladle 201*
Whiting Corp., One hundred ton locomotive shop truck 780*
Whiting Corp., Short-turn overhead trolley system 597*
Wiggin, Wesley J., Interesting examples of blacksmith shop work 703*
Williams, M. H., Manufacturing standard locomotive repair parts 451*, 511*
Williams, M. H., Speeding up locomotive main rod repairs 543*
Williams, M. H., Standard valve motion pins and bushings 39*
Williams, M. H., Successful methods used in repairing side rods 639*
Williams Tool Corp., Receding die head for pipe threading machine 721*
Wills, H., Making a drill live up to its reputation 249*
Wilmarth & Morman Co., Improvements in twist drill grinder 265*
Wodack Electric Tool Corp., Portable electric drill with automatic switch 132*
Wood, Arthur J., Insulation of passenger and refrigerator cars 547*
Wood, The use of, in freight car construction, by H. S. Sackett 105
Woodward & Powell Planer Co., Crank planer equipped with motor drive 392*
Wymer, C. J., Make car owners' responsibility complete 695

Y

Yale & Towne Mfg. Co., Storage battery truck equipped with crane 472*
Yazoo & Mississippi Valley, Device for spreading locomotive frames 380*
Yocum, C. E., High pressure pump for air test rack 118*

Z

Zernickow, O., Adjustable divided machine vises 593*
Zernickow, O., Speed and feed recording device 407*

APPOINTMENTS OF RAILWAY OFFICERS

Personals—General

Beames, Capt. H. P. M. 64
Brennan, E. J. 602
Callahan, J. E. 729
Carney, J. A. 666
Cromwell, O. C. 203
Garden, J. C. 203
Goodwin, G. S. 203
Gorman, Eugene R. 63*
Hartley, W. D. 138
Hoffman, C. M. 474
Jackson, O. S. 790
Kelly, John P. 328*
Kennedy, G. C. 729
Kershner, W. P. 411
Kirkland, A. W. 666
Klein, Alfred A. 64
Machovec, E. E. 790
McCormick, D. G. 203
McKernan, M. 602
McPartland, M. B. 328, 790
Modaff, H. 666
Nolan, J. C. 729
Preston, R. 138
Pyne, R. A. 138
Reese, O. P. 328
Roberts, John 203
Robinson, Frank S. 411
Robinson, W. L. 138
Salmon, H. W., Jr. 203
Sasser, J. W. 203
Seidel, G. C. 602

Personals—General—Continued

Sevier, C. J. 203
Smith, H. B. 63
Stephens, H. H. 138
Sturrock, A. 138, 203
Summers, E. J. 328
Temple, C. H. 138
Turner, H. C. 666
Wilcoxen, F. S. 729
Wildrick, F. D. 474
Wood, P. O. 203
Worman, H. L. 63*

Personals—Master Mechanics and Road Foremen of Engines

Adair, C. L. 138
Allan, H. M. 204, 270*
Allison, T. 602
Amy, H. A. 204
Bonney, H. G. 64
Carey, F. F. 204
Carr, T. E. 790
Chandler, J. W. 138
Denix, W. J. 204
Depue, G. T. 666*
Devine, A. 204
Ernstrom, G. L. 602
Fischer, F. G. 204, 269*
Flowers, A. J. 204
Freeman, E. G. 204
George, W. A. 64
Gibbs, F. A. 328
Gibson, J. 204

Personals—Master Mechanics and Road Foremen of Engines—Continued

Gilbert, L. W. 328
Gillispie, H. C. 64
Gould, J. E. 204
Green, W. M. 64
Hartley, W. D. 204
Hatch, M. C. M. 790*
Huffman, E. C. 411
Jones, J. 474
Keppel, J. W. 790
Knight, F. T. 474
Landis, S. L. 64
Lawler, G. M. 139*
Lemon, J. W. 64
Mailer, J. I. 533, 602*
Market, F. S. 204
McGann, C. E. 204
McSweeney, E. J. 474
Merritt, J. B. 328
Mordica, W. M. 64
Mozley, F. M. 790
Orland, B. Addison 666
Paradise, T. E. 411
Pearson, Lee 729
Peers, Alexander 138
Ray, G. W. 204
Reynolds, C. C. 474
Rheaume, R. J. 203
Roussin, T. A. 328
Schull, Eugene 204
Small, J. W. 296*

* Illustrated article; § editorial; † short, non-illustrated article or note; ‡ communication.

Personals—Master Mechanics and Road Foremen of Engines—Continued.

- Speigle, J. F. 411
- Stuvort, J. T. 328
- Turner, H. D. 411
- Tyler, L. C. 64
- Woody, E. R. 64, 138*

Personals—Car Department

- Allen, J. S. 533
- Bonner, B. J. 533
- Briggs, D. D. 533
- Demsey, H. T. 533
- Erickson, F. O. 64
- Greenwell, O. J. 204
- Gutteridge, J. 64
- Hanchett, S. F. 533
- Johnston, J. W. 64
- Kanatser, J. 533
- Krueger, A. J. 204, 329
- Litwin, Andy J. 270*
- McCullough, H. C. 533
- McDonough, J. 533
- Oakes, C. E. 64
- Pryor, G. E. 533
- Rankin, David M. 411
- Rhodes, J. C. 533
- Robider, W. J. 139
- Sanderstrom, J. R. 602
- Strauss, B. 533

Personals—Shop and Enginehouse

- Abington, W. T. 204
- Adams, Clarence W. 64
- Bickerton, Edward 329
- Birch, W. Arthur 270
- Callaher, E. F. 139
- Canfield, Geo. 666
- Cooper, H. M. 329
- Crowder, W. F. 790
- Danver, W. E. 329
- De Pue, G. T. 329
- Detrick, R. E. 602
- Eich, E. P. 729
- Fletcher, L. E. 64
- Garretson, John Edward 139
- Gibson, J. 790
- Grange, Harvey 729

Personals—Shop and Enginehouse—Continued

- Hambleton, A. 329
- Heise, George F. 270
- Hitch, C. B. 139
- Howell, Francis P. 64
- Lawler, G. M. 64
- Loud, Charles 329
- Manion, M. J. 602
- McGee, Minden 329
- McKenzie, J. 790
- McPherson, W. G. 790
- Murray, E. A. 139, 270*
- Powell, A. H. 790
- Ruick, Ernest 139
- Sasser, H. W. 729
- Schenck, Paul J. 411
- Schmidt, H. 603
- Sheppard, William John 533
- Shoup, C. E. 411
- Smith, B. H. 329
- Stanford, Lee 411
- Stone, G. M. 329
- Tuck, R. 139
- Wells, Harry E. 474
- White, Clarence 411
- Wilcox, W., 729
- Woods, J. A. 411

Personals—Purchasing and Storekeeping

- Bichlmeir, G. W. 64
- Blasie, J. F. 329
- Brain, B. B. 64
- Buchenery, H. P. 64
- Burnett, Edmund T. 139
- Burr, H. S. 603
- Concannon, H. W. 64
- Cook, Ernest O. 474
- Dearworth, C. W. 790
- Dougherty, C. A. 329
- Finch, J. W. 533
- Fowler, J. B. 64
- Goerner, G. A. 329
- Green, L. J. 329
- Griffeth, B. W. 329
- Heidenrich, C. F. 329
- Herrera, A. 329*
- Huffman, R. S. 329
- Jellison, B. T. 790

Personals—Purchasing and Storekeeping—Continued

- Johnson, J. W. 533
- Johnson, R. H. 603
- Keyes, M. H. 790
- King, W. H., Jr. 329, 411
- Kyle, C. C. 603
- Lavoie, L. 64
- McAuley, J. F. 64
- McKaig, W. J. 603
- Mahaney, J. E. 411, 474
- Manning, W. L. 533
- McCarthy, J. D. 729*
- Mello, A. J. 729
- Nelson, R. M. 411
- Osterman, F. 64
- Pauling, R. H. 790
- Pearce, H. C. 412*
- Pinion, G. H. 533
- Prentice, A. L. 329
- Reasor, C. K. 603
- Roesch, C. J. 603
- Ross, A. 790
- Sidey, W. J. 412
- Singleton, A. 729
- Sweeney, J. H. 729
- Talbot, F. J. 729
- Taylor, J. B. 329
- Taylor, V. R. 64
- Thomas, Gordon 603
- Velasco, J. M. 790
- Wharton, J. E. 270
- Wibel, W. L. 790

Personals—Obituary

- Boutet, Henry 412*
- Collinson, James D. 790*
- Cocke, C. J. Bowen 64
- Flanagan, M. 603
- Gaines, F. F. 603*
- Laizure, Riley 329*
- Leyonmarck, J. H. 603
- McDonnell, F. V. 329
- Miller, Robert Speer 65
- Oakes, Charles E. 790*
- Reading, Robert Kennedy 474
- Small, H. J. 65*
- Vogt, Axel S. 790

SUPPLY TRADE NOTES

- Abel, W. F. 791
- Acorn Refining Co. 475
- Adams, C. E. 139
- Air Reduction Sales Co. 65, 139, 331
- Aldrich, William 534
- Allegheny Steel & Tube Co. 204
- Allen, W. C. 667
- Allied Machinery Co. of America 533
- American Arch Co. 330
- American Automatic Connector Co. 475
- American Brake Shoe & Foundry Co. 142
- American Co. 330
- American Flexible Bolt Co. 475
- American Foundry Equipment Co. 65
- American Machinist 665
- American Malleable Castings Ass'n 67
- American Sheet & Tin Plate Co. 730
- American Spiral Spring & Mfg. Co. 413
- American Steel & Wire Co. 667
- Armstrong Mfg. Co. 270
- Atlas Valve Co. 204
- Austin, W. L. 204
- Automatic Coupler & Trailer Equipment Co. 413
- Automatic Straight Air Brake Co. 413

- Bacon, John L. 204
- Baker, George 65
- Baldwin Locomotive Works 66, 204, 668, 731
- Barbour, Love & Woodward 533
- Barco Mfg. Co. 139
- Barden, George A. 730
- Barrett Co. 603
- Basford Co., G. M. 330
- Bastian-Blessing Co. 65
- Bebb, R. E. 731
- Beck, George P. 204
- Becker Milling Machine Co. 205
- Beck-Hill Corp. 65
- Bell, B. A. 204
- Bell Locomotive Works 66
- Bellman, R. S. 475
- Bethlehem Steel Co. 330
- Bethlehem Shipbuilding Corp. 667
- Bettcher, Carl W. 270*
- Betts Machine Co. 603
- Bigelow, George S. 139
- Billau, H. E. 730
- Bilter, Raymond R. 412
- Blackall, R. H. 667
- Black, Robert D. 667
- Black & Decker Mfg. Co. 65, 204, 667
- Blaw-Knox Co. 730
- Bleecker, W. R., Jr. 475
- Bloss, Will H. 534
- Boe, Warren J. 330
- Bole, Robert A. 331*
- Bolling, Stewart 270
- Bosworth, William 791
- Boyd, Oliver G. 413
- Bradford Draft Gear Co. 140
- Brennan, E. J. 533
- Brewster, Morris B. 730
- Bridgman, Robert L. 413
- Bridgeport Brass Co. 668
- Brigham, C. F. 331
- Brown & Sharpe Mfg. Co. 205
- Browne, Robert L. 67
- Buker, Edward 65
- Burden Iron Co., Railroad and Steamship Division 476, 533
- Bureau of Foreign and Domestic Commerce 792
- Burkholder, C. J. 534, 730
- Burwell, P. V. 65
- Butler Drawbar Attachment Co. 270

- Cady, F. C. 65
- Caldwell & Son Co., H. W. 475
- Canadian Locomotive Co. 475
- Canton Foundry & Machine Co. 475
- Caton, William Jordan 476
- Caracristi, V. Z. 412*
- Carlton, James C. 65
- Carroll, Walter C. 791
- Castle & Co., A. M. 271, 330, 533
- Central Steel Co. 731
- Chain Belt Co. 731
- Chambers Valve Co. 140
- Chamberlin, Charles M. 330
- Charbono, F. H. 65
- Chase, C. C. 731
- Chicago Flexible Shaft Co. 204
- Chicago Pneumatic Tool Co. 66, 140, 330
- Chicago Railway Equipment Co. 668, 730*
- Chicago Varnish Co. 139
- Chicago Varnish Works 791*
- Cincinnati Grinder Co. 331
- Clark, V. D. 730
- Clement, Don L. 67
- Cleveland, O. D. 271
- Coburn, Ralph G. 332*
- Cocker, T. E. 731
- Combustion Engineering Corp. 475
- Commonwealth Steel Co. 271
- Condit, H. K. 66
- Conewango Car Co. 667
- Connelly & Kendal Co. 534
- Conners, Fred C. 330
- Connors, J. J. 330
- Conveyors Corp. of America 139, 271, 331
- Cooper, Ralph S. 413
- Copeland, Charles 533
- Craig, Edward A. 668*
- Crellin, E. W. 534
- Crerar, Adams & Co. 534
- Crocker-Wheeler Co. 667
- Cross, C. W. 475
- Cunningham, Frank H. 534
- Currie, James C. 67
- Curtis, F. W. 330
- Cutler, William F. 142

- Dallam, L. R. 331
- Davidson, H. O. 730
- Davis, J. M. 413*
- De Lancey, Darragh 534
- Denison, E. B. 667
- Detroit Seamless Steel Tube Co. 791
- Dietz, Carl F. 668*
- Dodd, Theodore L. 204
- Dominion Oxygen Co. 533
- Down, Signey G. 730*
- Dressel Mfg. Corp. 475
- Dudley, S. W. 206*
- Duff Mfg. Co. 65
- Duffield, L. R. 476
- Dunbar Mfg. Co. 66
- Duncan, John 603
- Dunn Co., W. T. 330
- Duntley-King Pneumatic Tool Co. 413
- Duntley Pneumatic Tool Co. 413
- Du Pont de Nemours & Co., E. I. 475, 533
- Du Pont, Alexis I. 475
- Durant, H. S. 667

- Eastern Machine Screw Corp. 270
- Eckels, Wilber 413
- Economy Fuse & Mfg. Co. 65
- Edwards Co., O. M. 65, 603
- Eggert, C. A. 65
- Eissler, R. F. 140
- Electric Alloy Steel Co. 791
- Electric Storage Battery Co. 791
- Elliott Co. 331, 475
- Ellis, Clifford J. 205*
- Elvin Mechanical Stoker Co. 141, *332
- Emery, E. 205*
- Emery Sales Co. 205
- Engineering Advertisers' Association 272
- England, Alexander 206*
- Englebright, E. W. 141*
- English Electric Co. of Canada 667
- Equitable Equipment Co. 271
- Evans, Harry M. 205*
- Evans, Keith J. 272

- Fairbanks, Morse & Co. 476
- Falls, O. E. 67
- Falls Rivet Co. 66
- Ferguson, H. K. 270, 412, 791
- Finnell, Harry W. 413
- Firth & Sons, Thos. 667
- Flood, Henry, Jr. 667
- Floor, E. J. 475
- Floto, M. W. 667
- Flynn, J. B. 331
- Foote-Burt Co. 142
- Foran, George Jesse 476
- Forsythe, Homer J. 413
- Fosdick Machine Tool Co. 331
- Foster Machine Co. 475

*Indicates photograph.

Franklin Railway Supply Co..140, 204, 205, 330, 331, 534, 730
Frink, O. B. 731

Galena Signal Oil Co. 412
Garvin Machine Co. 603
General Motors Corp. 475
General Railway Devices Co. 65
Geometric Tool Co. 475
Gerdes, Henry T. 475
Germain, Edward B. 667
Gibbs & Hill 731*
Gilmore, T. N. 730*
Given, William B. 142
Glidden Co. 140, 204, 330, 603
Goddard & Goddard Co. 533
Gold Car Heating & Lighting Co. 330
Goodwillie, E. E. 330
Gould Coupler Co. 412
Grant, Max....204, 330*, 475
Graves, A. D. 140*
Gregg, M. E. 791
Greenfield Machine Co. 475
Greenfield Tap & Die Corp. 475
Greenwood, Thomas H. 667
Griffin Wheel Co. 791
Griffiths, F. J. 731
Grigg, Frank N. 331

Hackathorn, C. F. 331
Hallidie Machinery Co. 139
Hammond, Robert S. 603
Handlan, A. H., Jr. 667
Handlan-Buck Mfg. Co. 667
Handlan, E. R. 667
Handlan, E. W. 667
Hansen, John M. 204
Hardin, C. M. 412
Harrington, Robinson & Co. 667
Hartley, W. A. 413
Hartman, Bruce 66
Hatch, Ralph T. 330
Hauck Mfg. Co. 475
Heibel, Walter E. 791
Henderson, George R. 731
Henderson, Harold G. 791
Heywood Brothers & Wakefield Co. 65
Hickman Lumber Co., W. R. 331
Hides, Horace C. 667
Highland Iron & Steel Co. 667
Hill-Curtis Co. 533
Hobbs, C. H. 791
Hoffstot, Henry P. 792
Horton & Son Co., E. 330
Hudson, E. E....332, 533
Hultgren, David A. 667
Hutchins Car Roofing Co. 330
Hus[illegible] J. F. 66
Hyatt Roller Bearing Co....413, 475

Illinois Car & Mfg. Co. 271
Independent Pneumatic Tool Co..65, 270, 413, 730
Industrial Car Mfgrs. Institute 412
Inland Steel Co. 791
Iron & Steel Products Co. 413

Jackson, W. H. 534
Jacques, H. W. 67
Jarvis, Chas. L. 475
Jewett, F. B. 534
John, Alba B. 204
Johnson, F. A. 204
Johnstone, Homer C. 412
Jones & Co., B. M....66, 330, 534
Jones, G. H. 791
Jones, R. J. 413
Jones & Laugblin Steel Co. 413
Joyce, Patrick H. 667

Kadie, C. H. 331
Kardos, E. 534
Kearney & Trecker 667
Keller, H. G. 65
Keller Pneumatic Tool Co. 413
Kellogg, F. L. 791
Kennett, Press G. 791*
King Co., H. O. 413
Kopf, J. C. 65
Kothe, Charles A. 475
Kramer, LeRoy 603
Kuehner, A. T. 204
Kyle, W. T. 414*
Kyte, William Archie 475

Lackawanna Steel Co. 791
Landis Tool Co. 330
Lane, William T. 331
Larsen, Lewis A. 141*
Laws, P. T. 791
Le Blond Machine Tool Co., R. K. 331
Lenhart, L. A. 204
Letts, P. R. 475
LeVally, John R. 139
Levenhagen, R. W. 140
Lewis, E. R. 204
Liberty Car & Equipment Co. 271
Lillis, De F....475, 533
Lilly, William 331
Lilly Varnish Co. 331
Link-Belt Co. 475
Lima Locomotive Works....141, 330
Lisle, M. E. 475
Locomotive Feed Water Heater Co. 205
Locomotive Superheater Co....139, 205
Longsworth, W. I. 331
Lowe Brothers Co....330, 667, 730

Madill, Thomas 667
Malott, C. M. 331

Manning, Henry S. 534
Manning, Maxwell & Moore....331, 413*, 533
Manufacturers Exhibition Co. 476
Marsh, Howard H. 141*
Marshall, Waldo H. 141
Marshall & Huschart Machinery Co. 331
Martus, Martin L. 534
Massey Concrete Products Corp. 667
Massillon Rolling Mill Co. 731
Master Tool Co. 475
Mawhy, F. J. 533
McDougall-Butler Co. 667
McIntyre, F. W. 331
McLaughlin, James 331
McMullen, J. H. 667
Meller, C. L. 139
Merrell, C. B. 65
Metal & Thermit Corp....67, 534
Metals Coating Co. of America 667
Midvale Steel & Ordnance Co. 205
Millholland Machine Co. 142
Millholland Sales & Engineering Co. 142
Modern Steel Casting Co. 65
Modern Tool Co. 330
Morgan Engineering Co. 791
Morgan Grinder Co. 475
Moore, A. Clarke....603, 730*
Moore, William H. 534
Morrow, L. C. 65
Morse, Charles Hosmer 476
Morse, E. A. 791
Morton, C. D. 66*
Morton, Harry U. 66*
Morton Mfg. Co....66, 331
Motch & Merryweather Machinery Co. 331
Mudge & Co. 667
Mull, Howard C. 140
Murray & Flood 667
Murray, William S. 667

Nathan Mfg. Co. 67
National Machinery Co. 533
National Malleable Castings Co....270, 730
National Pressed Steel Co. 731
Naugle, H. M. 731
Neilson, W. La Coste 668*
Nightingale, J. 475
Noble, W. H. 331
Norton Co. 668
Novo Engine Co. 730

Oatley, H. B. 271*
O'Connor, M. J. 533
Ogle, Robert A. 792*
Ohio Wire Goods Mfg. Co. 66
O'Malley-Beare Valve Co. 270
Orton & Steinbrenner Co. 791
Osborn & Co., Samuel 66
Overly, Charles F. 475
Oviatt, Harry L. 270
Oxweld Acetylene Co. 533

Paarman, H. A. 533
Page Steel & Wire Co....414*, 475
Peabody Fuel Co. 791
Peck, M. E. 475
Pelton Steel Co. 667
Pennsylvania Car Co. 667
Pittsburgh Des Moines Steel Co. 534
Pittsburgh Screw & Bolt Co. 271
Pneumatic Safety Valve Co. 66
Pollak Steel Co. 141
Poor, Fred A. 667
Porter Co., H. K. 331
Porter, H. Kirke 331*
Power Equipment Co. 271
Pratt, H. M. 270
Pratt & Lambert....67, 140
Prentiss & Co., Henry 331
Pressed Steel Car Co....331, 792
Pullman Co. 413

Railway Equipment & Publication Co. 330
Railway Materials Co. 330
Railway Supply & Mfg. Co. 412
Ralston Steel Car Co. 412
Ramsom, J. T. 413
Rastall, W. H. 792
Rawlplug Co. 534
Reade Mfg. Co. 139
Reading Steel Castings Co. 330
Redding, G. H. 667
Redhead, J. H. 731
Reed-Prentice Co....205, 330
Reeves, Judge F. T. 534
Reilly-Peabody Fuel Co. 791
Reliance Co. 731
Rhodes, Louis B. 204
Rider, James Brown 791*
Rittenhouse, J. A. 413
Robinson, John C. 667
Robinson, W. F. 412
Roebling's Sons Co., John A. 475
Roebling, Karl G. 475
Roebling, Col. Washington A. 475
Roehl, W. J. 271*
Rogotchoff Co....533, 667
Rogatchoff, Theodore 667
Rome Iron Mills 330
Root, Martin J. 139
Ross Heater & Mfg. Co. 412
Roth, Edward N. 667
Rubberoid Co. 330
Rushton, Kenneth 668*

Ryan, Allan A. 330
Ryder, G. E. 271*

Sanderson, Richard 66*
Sattley, E. C. 413
Sauter, F. H. 731*
Sawyer, D. E. 141
Schmidt, R. H. 475
Schoenmehl, Harold B. 534
Schumacher, T. M. 330
Schurch, J. F. 603
Sederquist, James W. 533
Seger, Charles B. 731*
Severin, F. G. 603
Sharon Pressed Steel Co. 475
Sheehan, F. E. 331
Sherritt & Stoer Co....65, 139
Sherwin-Williams Co. 730
Sinkler, Joseph 140*
Slater, James A. 730
Slimp, J. E. 667
Smith, A. E. 65
Smith, Frank P. 791
Smith Tool & Mfg. Co., R. G. 270
Snedeker, W. H. 791
Southern Iron & Equipment Co. 270
Southern Wheel Co. 272
Southwark Foundry & Machine Co. 270
Spencer, J. Brookes 272
Standard Coupler Co....139, 413
Standard Paint Co. 330
Standard Pressed Steel Co. 475
Standard Steel Works Co....66, 201
Standard Stoker Co....140, 204
Starrett Co., L. S. 413
Steel Fabricating Corp. 475
Stinson, R. A. 667
Stiteler, N. C. 668
Stone Franklin Co. 330
Stowell Co. 667
Street, Clement F. 412
Strips, W. C. 475
Stuart, C. E. 731
Sturtevant Co., B. F. 791
Sullivan, J. C. 668
Summa, Victor M. 533
Superheater Co....271, 330
Superior Supply Co. 730
Symington Co., T. H. 603

Teasdale, R. D. 667
Terminal Engineering Co. 475
Texas Co. 331
Toledo Bridge & Crane Co. 66
Toledo Crane Co....66, 205
Torchweld Equipment Co. 475
Torney, Harry W. 475
Traendly, G. J. 475
Tropical Paint & Oil Co. 412
True, C. H. 272*
Tube & Pipe Supply Co. 413
Tuco Products Corp. 603

Union Railway Equipment Co. 140
Union Tank Car Co. 65
United States Cast Iron Pipe & Fdry. Co. 791
U. S. High Speed Steel & Tool Co. 139
United States Metallic Packing Co. 603
United States Rubber Co. 731*
Universal Crane Co....330, 533
Universal Packing & Service Co. 533

Vanadium Corp. of America 330
Vacuum Oil Co. 475
Vanden Boom, G. C. 66
Van Schaick, A. P. 414*
Vapor Car Heating Co....204, 272
Verona Tool Works 140
Viall, Ethan 66
Victor Tool Co. 330
Victory Equipment Co. 141
Virginia Car Corp. 791

Wadsworth Electric Mfg. Co. 730
Waite, L. M. 603
Walker, Edmund H. 139*
Walworth Mfg. Co. 533
Warnock, Harry R. 140*
Waterbury Battery Co....332, 533, 534, 731
Watson, G. R. 730
Weaver, Cecil W. 667
Weber, C. R. 139
Webster & Perks Tool Co. 533
Western Electric Co....204, 534, 667
Westinghouse Air Brake Co....206, 667, 730*
Westinghouse Electric & Mfg. Co. 730
Wharton & Co., Wm. 667
Whitcomb-Blaisdell Machine Tool Co...205, 331
Whiting Corp....139, 603
Whiting Foundry Equipment Co ...65, 66, 139
Whitney, Ben L. 791
Widau, W. E. 475
Williams, Charles Haines 667
Wilson, Robert B. M. 331
Wilson, Stewart C....66, 603
Wilson, William C. 271
Wine Railway Appliance Co. 791
Wolfe, E. W. 331
Wolfe, William C. 667
Wood, A. C. 270
Woodworth, E. A. 603
Worthington Pump & Machinery Corp. 476

Young, Andrew G. 730
Youngstown Steel Car Co. 204

*Indicates photograph.

Railway Mechanical Engineer

Volume 95 January, 1921 No. 1

CONTENTS

EDITORIALS:
- A Unit That Will Measure 1
- Higher Steam Pressure in Locomotive Service 1
- Responsibility for Heat Treatment 2
- The Conservation of Lumber 2
- Advantages of Standard Valve Motion Pins and Bushings 2
- The Problem of the Railroad Clubs 2
- Fix Box Cars or Have Them Retired 3
- The Labor Policy of the Railway Mechanical Engineer 3
- New Books 4

COMMUNICATIONS:
- The New Haven Mountain Type Locomotives 5
- The Union Viewpoint on Labor Questions 5
- Management in Railroad Shops 6
- Save Fuel by Keeping Valves Square 6

GENERAL:
- Mechanical Equipment on the Tomsk Railway 7
- The Locomotive Terminal an Operating Factor 15
- Boards of Adjustment to Be Abolished 17
- Report of the Bureau of Locomotive Inspection 18
- Trailer Box with Lateral Adjustment 20
- Federated American Engineering Societies' Meeting 21

CAR DEPARTMENT:
- Ball Bearings for Railway Cars 23
- Pacific Fruit Refrigerator Cars 25
- Annual Report of the Chief of the Bureau of Safety 29
- Locking Device Applied to Station Baggage Trucks 30
- An Efficient Car Straightening Frame 31
- Lubrication of Freight and Passenger Equipment 33

SHOP PRACTICE:
- Belt Service and Length of Life 37
- The Equalization of Spring Rigging 38
- Limitations of Thermit Welding for Repairing Cast Iron 38
- Standard Valve Motion Pins and Bushings 39
- Management of a Locomotive Repair Shop 42
- Emergency Patch Plate Made of Old Air Signal Valve Part 46
- Heat Treating Steel in Railway Shops 47
- Repairing Cylinder Cap of Air Compressor Governor 48
- Stool for Supporting Front End of Boiler 48
- Standard Gages Facilitate Repairing Valves in Air Brake Department 49
- Power Punches and Dies 49

NEW DEVICES:
- Easily Applied High Speed Milling Attachment 51
- Exhauster Attachment for Surface Grinder 52
- Self-Loading Type Electric Truck 52
- Taper Attachment Applied to Boring Mill 53
- New Motor Drive for Internal Grinder 53
- Improved Automatic Collapsing Tap 54
- Easily Applied Self-Centering Steady Rest 54
- Hose Couplings for Pneumatic Tools 55
- High Speed Friction Metal Cutting Saw 55
- Twenty-Two Inch Drill with Stationary Head 56
- Lubricant for Locomotive Hub Liners 56
- Plain Milling Machine for Medium Heavy Work 57
- Belt or Motor Driven Variety Saw Bench 57
- Measuring Temperatures in Stored Coal 58
- Continuous Feed Disc Grinding Machine 59
- Power Feed Internal Grinding Machine 60

GENERAL NEWS:
- Notes 61

A Unit That Will Measure

There is hardly a phase of railroad operation which does not have some unit of measurement with which may be made comparisons that throw more or less illumination on situations and the trend of events. The real value of these units must be judged, first, by the accuracy with which the results of their use may be interpreted and, second, by the convenience of their application. It is unfortunate that some of those commonly used units have little to recommend them except the latter quality, and among these must be included the per cent of cars in bad order as a measure of freight equipment conditions. The percentage of freight cars in bad order conveys little real information as to the general condition of freight equipment. Neither is it an accurate measure of the amount of work awaiting the shop and repair track forces. This is evident from the fact that bad orders even now are classified as lights and heavies, but with the wide range in the amount of work which may fall in the latter group, the value of this classification for comparative purposes is open to serious question. The cars in bad order may require from four or five to several hundred man hours each, and before this rough classification can be made the estimated amount of work on each car must be known. The information, therefore, is available from which the bad order situation can be stated in terms of car repair hours almost as readily as the number of bad order cars are now roughly classified as lights and heavies. The number of car repair hours conveys an accurate picture of the size of the job facing the repair forces, and the trend of car repair hours will show much more accurately than the trend of the number of bad orders, to what extent the demands for repairs are being currently met. Furthermore, with this information it would be a simple matter to arrive at the number of repair hours per car. This would be a most useful unit, not only for following the trend of car conditions in general, but for comparing cars of one class with those of another in a study of the relative merits of different designs. It does not appear that there should be sufficient added inconvenience in the computation of car repair hours, with the basic data already at hand, to overbalance the value of the information as an aid to a more accurate understanding of freight car conditions.

Higher Steam Pressure in Locomotive Service

For approximately ten years past the steam pressure used on locomotives has remained practically unchanged. The increase from 140 lb. or 160 lb. to 200 lb. per square inch occurred in a period of a few years. Some roads went to extremes and designed locomotives for 240 lb. pressure, but the investigation of Dr. W. F. M. Goss showed that in a locomotive of a given weight, greater economy could be secured by using a pressure of about 200 lb. than by raising the pressure and decreasing the size of the boiler to keep within the prescribed weight limit. Later when tests with superheated steam proved that the steam consumption per horsepower hour was practically constant over a considerable range of pressure, some roads went back to lower pressures of about 180 lb. to 185 lb. As the diameter of locomotive cylinders has now been increased as much as the clearance on many roads will permit, the next logical step would seem to be an increase in the boiler pressure. In fact this is an inevitable development, for since the stroke of the cylinder and the diameter of the driving wheels are practically fixed, the power output is limited unless the pressure can be raised. The Pennsylvania System adopted a pressure of 250 lb. for its Decapod locomotive and while this is a special case higher pressures are likely to be more generally adopted in the near future. Previous experience shows that satisfactory boiler maintenance becomes much more difficult at pressures above 220 lb. per square inch, but when the necessity for higher pressures develops, some means of overcoming it will surely be found though it may lead to the adoption of a different type of boiler for locomotive service.

Responsibility for Heat Treatment

With carbon tool steel at 18 to 25 cents a pound and high speed alloy steel costing around $1.25 a pound, the question of responsibility for the heat treatment of tool steel in railway shops becomes all important. In by far the larger proportion of shops the furnaces, small automatic air hammer, brine baths and other equipment used for dressing and hardening tools is located in the tool-room, but in many cases the tool-maker is responsible to the blacksmith shop foreman for both the quality and quantity of his work. This practice is a mistake. The tool-room foreman should have control of the heat treating department and specify the steel that goes into all tools heat treated at the shop where he is located. Knowing the conditions under which each tool is used, he is the one best adapted to specify the kind of steel needed and the particular heat treatment which will give the best results. The condition of a tool depends upon two things other than the workmanship in its manufacture; namely, the kind of steel as to carbon or alloying elements, and their percentage proportion; the other, the heat treatment. The man doing the heat treating should not be placed under the master blacksmith who often has too many other duties to specialize in the finer art of heat treating tools. In practically every case the manufacturers' recommendations as to the best heat treatment for a particular high speed steel should be rigidly adhered to. The tool foreman, having ordered the steel, is in a position to know what treatment is recommended and should be made fully responsible for the apparatus, methods used and men employed in the heat treating department.

The Conservation of Lumber

Few mechanical engineers appreciate the fact that following labor and fuel, lumber is the largest single item of expense to the railroads. It is quite possible that the unit cost of this material may drop more rapidly in the immediate future than the cost of either labor or fuel; but, in the long run, lumber is certain to increase in price as the available supply approaches a state of exhaustion. This is best emphasized by the fact that approximately one-half of all the available timber in this country is now located in three states bordering on the Pacific ocean. A survey of the records showing the annual rate at which lumber is being consumed in this country is even more startling. As a result of this situation, the railroads are already using grades that not many years ago were thought impossible and it is a certainty that within an equally short period mechanical engineers will be faced with the necessity for specifying grades of lumber for cars and other structures that are now regarded as unfit for this use. But, this being a fact, why should not mechanical engineers anticipate this situation, particularly if the use of a slightly lower grade at this time will reduce the cost of the lumber? In this connection the following is quoted from a paper presented at a recent meeting of the Forest Products section of the American Society of Mechanical Engineers:

"In the early days when the supply of wood in this country was thought to be inexhaustible, clear grades of wood were generally demanded by the car builders, and in the construction of new cars this is generally the practice at the present time, especially for car roofing and siding—sound-knotted stock being used for decking and lining. Some of the more progressive railroads, however, have gone a step further in recent years and many are now using sound-knotted stock for siding and roofing for repair and maintenance work. There is no doubt but that such a practice is economical and based on sound judgment, for certainly there is no necessity for using clear material for the repair of many classes of freight equipment, the life of which may not be in excess of seven to ten years. One large railway system which not only constructs its own cars but does repairing on a large scale, has adopted practice as to grades which has resulted in a saving to this railroad of over half a million dollars per year."

Undoubtedly mechanical engineers would prefer to follow the safe course and specify only those grades of lumber which they know have proved satisfactory. It is advisable, however, that they should do more than this; they should make certain that a less expensive grade will not answer the purpose before committing the railroad to the more expensive grades. This calls for a departure from the beaten path and a degree of courage which, however, should not be lacking.

Advantages of Standard Motion Pins and Bushings

Elsewhere in this issue is an article on "Standard Valve Motion Pins and Bushings" which should be of especial interest and value to railway shop executives and those responsible for the accurate and prompt repair of motion work in machine shops. It is a notorious fact that in repairing locomotive valve gear parts, pins and bushings of almost every possible size are used and the time required for making so many different sizes together with the individual fits, represents a large amount of money at the present cost of labor. The subject of standardization has already received careful attention in certain railroad shops and the article referred to outlines a method of manufacturing and fitting standard grade sizes of motion work pins and bushings with a considerable decrease in cost and increase in shop production. Among the important advantages resulting from the method explained is the fact that it permits manufacturing pins and bushings in large quantities with modern machines at central production shops. By grinding all of the bearing surfaces in one shop, this work can be performed more economically and accurately than heretofore. Most railroad shops are limited in output due to inadequate machine departments and valve work especially is often not completed on schedule time. The advantages of carrying standard pins and bushings in stock finished to the point of turning the taper ends and the outsides of bushings is especially apparent in these cases. Another advantage from the back shop point of view results from the fact that any pin will fit any bushing of the same class. Levers can thus be changed from one locomotive to another without refitting, a condition which is impossible without standard parts.

The Problem of the Railroad Clubs

Addressing members and guests of the New York Railroad Club at the recent annual dinner, the retiring president referred to the excellent character of the papers that had been presented to the club during his term of office. But he also commented upon the lack of discussion following the presentation of these papers and stated that it had proved a most difficult matter to draw out the sort of discussion that is most needed. Those who are best informed upon a subject are often the most reluctant to participate in the discussion, which, as a result, frequently terminates before any additional facts are developed or it drifts into other channels that have no particular bearing on the subject. This is indeed the problem of every railroad club, the real value of whose activities may usually be judged by the breadth and scope of the discussion. In fact, many papers presented at these clubs are designed mainly to provoke a discussion that will bring out the most salient points in connection with the subject. Since a majority of the papers presented at all the railroad clubs relate to mechanical matters, this situation should be of particular concern to all mechanical men who are so fortunately situated that they can attend these meetings.

Any man who holds decided opinions upon the subject of a paper and has the courage to deliver these views before a body of men, should not fail to take advantage of the splendid opportunity presented at these meetings for accustoming himself to public speaking. If he can deliver his remarks without the aid of notes, so much the better, provided he bears in mind that it is the text rather than the manner of delivery that is most important. In this connection, the activities of the Railroad Section of the American Society of Mechanical Engineers should not only be commended but might well be observed as a model for the railroad clubs. Following the choice of a subject and the selection of a speaker, the committee proceeds to invite a number of the best posted men available to discuss the paper following its presentation. Having secured the acceptance of a sufficient number of men to assure a well rounded discussion, the matter is not allowed to rest but each of these men is advised the length of time available for his discussion of the subject, and subsequent notices are addressed to him in reminder of the meeting. As a result, a broad instructive discussion is developed. In answer to any objection on the ground that this mode of procedure would tend to stifle general discussion of the subject, it may be said that the plan, if it does not involve too lengthy a discussion, will in fact, tend to stimulate more animated general discussion than would occur had no part of the discussion been planned in advance.

Fix Box Cars or Have Them Retired

The outstanding features of recent developments in the car situation, so far as it affects the car department, are the marked increase in the number of cars being returned home and the increasing number of heavy bad order box cars. Between July 15 and November 15 the cars at home increased from 26 per cent to 32.5 per cent of the cars on lines. During the same period the per cent of bad order cars of home ownership increased from 57 per cent to 67.6 per cent of all bad order cars. For box cars alone this increase has been from 46.5 per cent to 63 per cent, and a somewhat similar, though smaller, increase also applies to gondolas. But there has been an appreciable reduction in the number of bad order gondolas, both light and heavy, while the increase of about 8,000 heavy bad order box cars has been only partially offset by a decrease of about 3,500 in the number requiring light repairs. These figures indicate that the large amount of heavy repairs that were made to gondolas during the summer and fall, both in railroad and contract shops, is proving effective, but that the opportunity has only recently presented itself for effectively attacking the box car situation. Such an opportunity presents itself only when traffic is comparatively light, because box cars scatter rapidly when there is a car shortage. It is evident, therefore, that any improvement in the situation must be made now and during the remainder of a period of light business of uncertain duration if it is to be made at all. The need for supreme effort to bring about this improvement before the cars get away from home again is greater than can be inferred directly from the accumulation of bad orders. The retirement of about 135,000 freight cars with replacements probably not exceeding 20,000 or 30,000 has caused a depletion in the supply of equipment, of which probably three-quarters is box cars. This depletion was caused not by deferred retirements alone but by deferred maintenance as well, and should the present opportunity to rehabilitate large numbers of the older cars which are now at home in bad order, be neglected, their retirement from service may become compulsory before another opportunity to salvage them is offered. The railroads can ill afford any further extensive depletion of the box car supply during a period of heavy traffic until deliveries of new cars have become extensive enough to greatly outnumber the retirements.

The Labor Policy of the Railway Mechanical Engineer

Among the Letters to the Editor in this issue there appears a communication from a subscriber who evidently feels that the policy of the *Railway Mechanical Engineer* in regard to labor matters is unfair to the workers. While some of the statements made are apparently based on a misconception of the intent of the articles to which they refer, they are printed in full, as a few comments on the letter should serve to bring out clearly the editorial policy on this important subject.

The entire tone of the letter indicates that the writer feels that labor conditions were uniformly bad prior to federal control and the only hope for the employees in the future lies in the adoption of the Plumb plan. The autocratic stand taken by some railroads in the past is criticized. It must be admitted that abuses existed, but they also existed in other industries at the same time. Labor conditions in general have improved in the last few years and the railroads have developed their policies in accord with the spirit of the time.

The right of the employees to have a voice in fixing wages and working conditions is now generally conceded. This right is assured to the railway workers under the Transportation Act. The form which employee representation should take is a matter that should be left open to be determined by the management and employees on each individual railroad. Certainly the close contact between the management and the workers necessary for harmonious and efficient relations will not be promoted by the centralization of authority in national boards of adjustment. Granting the right of the employees to organize, the employers on the other hand have a right to demand that each employee shall give a fair day's work, that working agreements shall be so framed that they do not hamper production without cause and that promotions to supervisory positions shall be based not on seniority but on ability.

The section of the letter dealing with the Plumb plan compares it with the present Transportation Act. The writer makes a statement that the railroads are guaranteed a definite rate of return, but this has been disproved so often that it hardly seems necessary to point out once more that the return is conditional on the efficient operation of the property. The statement that interest is paid on watered stock is equally misleading. The value upon which the earnings are based is determined by the Interstate Commerce Commission. With the data obtained in the federal valuation reports the commission is certainly in a position to decide on a fair value for the property of the carriers.

To deal with all the questions brought up in the letter would make this article too long, but some of the statements regarding the present attitude of the railroads toward their employees can hardly be passed by without comment. To complain because the railroad managers did not acquiesce in all the demands made by the employees of the labor board hearings seems unreasonable. The Transportation Act places responsibility for efficient operation on the management, but it would hardly be consistent for them to claim that they were managing their property efficiently if they advocated fixing rates for labor higher than the prevailing scale in other industries. As a matter of fact, the railroads recommended that some classes of employees be given the full amount of the increase which they requested.

The concluding paragraph of the letter discloses a lack of knowledge of the fundamentals of economics that is responsible for much of the labor trouble at the present time. Wages, prices and business conditions are not manipulated by any small group of individuals, but are determined by fundamental economic laws. The employees and the managers have far more interests in common than is generally realized. The hope of improved conditions in the future lies in the more general realization of these mutual interests and the development of a spirit of co-operation instead of antagonism. A masterly treatment of this question will be found in the address by Herbert Hoover published in this issue, which outlines a program for industrial and social progress that should appeal alike to employer and employee.

NEW BOOKS

The Engineering Index for 1919. Published by the American Society of Mechanical Engineers, 29 West 39th street, New York. 527 pages, 6 in. by 9 in. bound in cloth.

The purpose of the Engineering Index is to provide a convenient and satisfactory guide to engineering literature. The 1919 edition of this index is the most complete and comprehensive work of its kind ever published. It contains over 12,000 references to articles published during the year 1919 in nearly 700 engineering and allied technical publications. The compilation of this index is based upon a review of approximately 1,100 periodicals, reports, and other publications by the engineering staff of the American Society of Mechanical Engineers. These publications are printed in ten different languages and comprise what is probably the most complete collection of scientific and engineering publications in the world. All of the publications referred to in this index are now a part of the Engineering Societies Library in New York.

Fuel Oil In Industry. By Stephen O. Andros. 240 pages, 6 in. by 9 in. Illustrated. Bound in cloth. Published by the Shaw Publishing Company, 910 South Michigan Boulevard, Chicago.

The use of fuel oils by the railroads is by no means new and the problems involved in its application to the locomotive have been carefully studied by railway engineers for many years; in fact, the value of this book to the railway mechanical or civil engineers might be questioned if it were not for the tremendous expansion in the use of fuel oil in all industries within recent years. Thus the increased price of bituminous coal has assisted in promoting the use of fuel oil both in maritime service and in many hundreds of stationary plants along the eastern seaboard. This in turn has introduced new problems relating to its transportation in bulk and storage in large quantities. Moreover, it must be admitted that refinements bearing upon the handling and burning of fuel oil are generally given more consideration in stationary and maritime service than in railroad use. For this reason, there is a field for a book of this character in railroad as well as industrial service which outlines, as it does, not only the principles of fuel oil combustion and the properties of fuel oils; but the methods of testing, storing and burning it together with a full description of its application to industrial and domestic furnaces. For instance, the book not only describes many of the details involved in the construction of steel storage tanks but refers to an interesting development in concrete oil storage tanks and describes at length all of the pipe setting and auxiliary machinery involved. While the book describes many types of burners that would not be applicable to locomotive service, still there are many points in connection with this subject as outlined in this book that will prove of particular interest to railway fuel engineers. The use of fuel oil in the manufacture of iron and steel and the heat treating furnaces is also described and illustrated in an interesting way.

Export Register of the Federation of British Industries. 328 pages and catalogue section of 312 pages, illustrated, 7 in., by 9½ in. Bound in cloth. Published by the Federation of British Industries, 39 St. James street, London, S. W.-I, England.

The trade organization movement in Great Britain has made great progress in recent years. One of the most notable recent developments was the inauguration of the Federation of British Industries in the summer of 1916. This body has enrolled 1,300 members including 200 trade associations. The Export Register recently published by the federation is probably the most comprehensive directory of British industrial firms yet prepared. The industries are divided into 20 groups which are in turn subdivided according to the specialized branch of the industry which the producer serves. A list of companies, firms and their agents, with sufficient information to enable the buyer to get in touch with the nearest agent, is given. Another section of the book is devoted to a very complete list of products with the names of the manufacturers represented in the federation. An extensive section devoted to advertising enables the individual manufacturers to give further information concerning their wares. This book might well serve as a model for American export associations in furthering their interests in the foreign field.

The Locomotive Up to Date. By Charles McShane. Revised edition, 893 pages, illustrated, 6 in. by 9 in. bound in cloth. Published by Griffin & Winters, Chicago.

The remarkable development of the locomotive and locomotive appliances which has taken place since this well known book first appeared in 1899, made a revision imperative if it were to continue to be of current interest. This work has been performed by Charles L. McShane. The book is non-technical in character and in many respects perhaps too superficial in its treatment to be of value to any one but a novice in locomotive design, maintenance or operation. Its great appeal will probably be to the young machinist and the apprentice, and perhaps to some extent to the locomotive fireman. By far the greater part of the space devoted to descriptive material is taken up with locomotive specialties rather than with the construction of the locomotive itself and the revision has consisted largely in bringing these sections up to date. So many of the more recently developed locomotive appliances, some of them well established, are so lightly touched, if touched at all, that the volume can hardly be said to justify its title, even in the field to which most attention has been given. In the revisions of those sections dealing with breakdowns and shop work no account has been taken of the requirements or effects of the Interstate Commerce Commission locomotive inspection rules and the revision has failed to disguise the fact that these sections are most directly applicable to the motive power of 20 years ago. Over one-third of the volume is devoted to valves and valve motions, and the sections dealing with these subjects are the most thorough and complete of any in the book. The fundamentals of valve motion and the determination of valve proportions and events have been thoroughly handled in so simple a manner that they may readily be comprehended by the novice while still offering much of interest to those of greater experience. All of the valve motions now used in locomotive service are described and instructions for valve setting are given in each case. From the standpoint of the young machinist, only second in importance to the sections dealing with valves will be found those on shoes and wedges, the laying out and fitting of which have been fully explained, numerous sketches adding to the clearness of the explanation.

COMMUNICATIONS

The New Haven Mountain Type Locomotives

New Haven, Conn.

To the Editor:

I noticed with considerable interest the description of the Mountain type locomotives for the New Haven and at the same time I have observed a few things that are not absolutely correct. This article states that engines were equipped with a Unit drawbar. This is not true, as it was necessary, by reason of design, to forego the use of the Unit drawbar. It is also stated that the Lewis power reserve gear is used, whereas the locomotives are equipped with Ragonnet, Type *B*. Moreover, the cylinders were not cast with by-pass valve chambers as stated in the last paragraph of "changes in the standard design."

On the same page, second column, it is stated that the object of designing a single hopper ash pan was to facilitate future application of the booster. While in a measure this is true, it was also found possible to increase the capacity of the pan approximately 15 per cent over the government design and at the same time dispense with necessity for two hoppers.

J. C. Hassett,
Mech. Engr. N. Y., N. H. & H.

The Union Viewpoint on Labor Questions

San Antonio, Texas.

To the Editor:

I find an article in your November issue in which the writer says much will have to be done before we get back to pre-war conditions. As a representative of labor, I beg to inform him that the workers have no intention of going back to pre-war conditions, now or at any other time, as we suffered too many hardships under those conditions. We have therefore formed ourselves into different organizations and made ready to protect ourselves and our families from the employer who would have us work for a bare living under whatever conditions he saw fit to impose.

We fully understand that pre-war conditions means that the employer wishes again to have undisputed control over his employees, to deal with them as he sees fit, regardless of what they may want or desire; in other words, he wants them to become automatons, without the right to think for themselves.

We can all remember the time when the workers first asked for the eight hour day, how these same men told the public that the eight hour day meant the destruction of the country, and again when the nine hour day was forced upon them, they tried to make the public believe that the workers were trying to destroy the commerce of this country by not producing enough to supply the demand. Now we have the eight hour day and wages which allow us some of the comforts of life and a chance to give our children an education which before we were compelled to deny them.

We find that according to the newspapers the workers are again about to destroy the universe in which they live, but we have lived through the signing of the Declaration of Independence, the abolition of slavery, the establishing of prohibition, woman suffrage, and we will allow the workers to get their rights without destroying the country or even being sorry for any of these changes for the betterment of mankind.

This writer complains that the shops are burdened with a class of men who claim to be mechanics, but who are not able to produce a day's work for a day's pay. The most of these men were employed in these same shops before the war and were classed as handy-men; their wages averaged very little more than that of the common laborer. They were trained by their employers in order to get cheap labor, instead of paying mechanics to do mechanical work. The employers insisted on using these men as long as they could get them for small wages and force them to work under conditions that no mechanic would tolerate. Now that these men are demanding that they be paid a living wage, he has no further use for them, but wants to throw them out until such time as they have been starved into submission and the acceptance of a lower wage, or he would be even willing to use them as he has in the past as a strike breaker, in case his mechanics get too bold and demand their just share of the profits of the business of which they are the most vital part.

When the railroads went under federal management there was established a sliding scale of wages for this class of employees; under its provisions a man became a full rated mechanic after he had worked four years at a trade. If the management had done their part and given these men a chance to learn all branches of the trade during this four years, they would have had nothing to complain about at the present time. They made no effort to train these men, and now they find themselves confronted with the problem of making these men earn their salary, when they are only able to do one class of work.

I find these men very anxious to learn and make something of themselves and using every means in their power to make themselves mechanics. Some even go so far as to quit the shop and go to a strange shop and hire out as a mechanic, working as long as they will allow him, and then going to some other place where he is not known and repeating the same thing, until at last, after many hardships, he is able to hold a job. These are the men the writer complains about and asks the mechanics to allow them to turn them out on the streets.

I believe these shops owe it to these men whom they have started to make mechanics of to allow them to finish their trade in the shop where they started and where the employer received the benefit of their cheap labor before the war. Make them proficient workmen; give them mechanics' pay, and then stop making jack-leg mechanics and handymen.

The railroads are asking that they be allowed to deal with their employees individually, but they are not willing to be dealt with individually; they still want to be guided by their organizations and be banded together as one body in dealing with the employees; we want a fifty-fifty deal, that's all.

In the other article to which I take exceptions we find this statement, "Under the Plumb Plan the public would buy the roads and guarantee their operating expenses and the interest on the money invested in them."

Under the present plan we are not buying the railroads, but we are guaranteeing the operating expenses, and the interest on not only the money invested, but also six per cent on the watered stock. In this way the public is assuming all the risk and getting absolutely nothing in return.

The statement is made that under the Plumb Plan the surplus money earned would be divided, one-half going to the workers. How about the present plan; what will become of the surplus earnings? Will the worker get their share, or will the public get any of it, or will it be as it has been in the past: the favored few stockholders adding a little more watered stock and getting away with the cash? This article claims that no business is well managed unless it is handled by the owners or in their behalf. How, then, are we to account for the many successful enterprises now being run under municipal management? We find cities running water works plants, street cars, light plants and many others too numerous to mention, and they are paying better than they did under private management. Besides, the employees are better paid than they were under private control.

As an instance of this I beg to call your attention to the city of Cleveland where a few years ago the city was taxed to pay for the collecting of the garbage, while at the present time, under municipal management, the city receives several thousand dollars by the sale of its garbage, besides having it collected free to the public.

The language of this article would lead one to believe that the last increase in pay granted the railroad men was given by the private owners, whereas they used every means which they had in their power to prevent the men getting this increase.

The claim is made that this shows that the men would be able to get just treatment under private management, but their actions in the past, to say nothing of the present, does not bear out this claim. In the past the men were forced to work piece work, premium work and bonus work and goodness knows what else, no matter how much they protested against it.

During federal control these things were done away with by the vote of those who were trying to exist under these systems, and this vote was so strong in favor of abolishing these methods that the government granted the request of the employees.

Since the roads have gone back to private control they are using every means in their power to reestablish these old practices, which the men who work in the shops have said they do not want.

You state that it would be possible for the men to own the roads by simply buying up the stock of the different roads. My experience has been that some of the large roads have tried this plan to get control of smaller side lines, which they needed as feeders for their main lines. If history is correct in its statement on these deals, and I believe it is, they found this not only an expensive proposition but often an impossibility, as the stock markets are not so easily handled as this statement would lead us to believe.

The money to make this purchase possible is to be taken from the last increase in wages which the workers received, but it is a well known fact that this increase was only granted after it was conclusively shown that the men were not able to live on the wages they were receiving, yet they must take this money and buy the roads and deny themselves the necessities of life. This is called thrift, but it is the kind of thrift we always want the other fellow to practice but do not care to indulge in ourselves. The writer sees in the failure of the employees to do this proof positive that they would not be able to run the roads if they were given the chance. He overlooks one essential point, and that is that the owners do not run the roads but hire men to do it for them. We find that few of the men who are held responsible for the running of the roads own any of the stocks of the road they are managing. We well know that when there is any question of any consequence to be settled it is the men who are paid a salary that are called upon to handle it and not the owners. It is the brains that a road is able to buy that makes it a success or failure, not the brains of the men who own the stocks. The owners are more concerned about the price of the stocks and the amount of their dividends than they are about the way their roads are run, except as an investment.

The managers are trying to make the public believe that the workers are being paid too high a wage. Did you ever stop to think why wages were so high? Most of the men who own the greater part of the railroad stocks are also owners in part of some other business which was responsible for these high prices of which we all complain. Then they must be responsible for the high cost of living and also the high cost of labor of which they are now complaining. They are even now trying to create a bread line to reduce the price of labor and make the worker submissive to their will.

L. S. Kronheimer,
Chairman, Local Federated Shop Crafts, G. H. & S. A.

Management in Railroad Shops

Salt Lake City, Utah.

To the Editor:

The editorial on Systematizing Management in Railroad Shops, published in the November issue of the *Railway Mechanical Engineer,* deals with a subject of the utmost importance. I believe that a close study of this question will lead to the conclusion that job analysis and job specification, carried on by a competent committee of both officers and employees, and under the supervision of a personnel department is the only logical solution. The committee on job analysis should be composed in part of mechanical officers who would work with a committee appointed from each shop on the line, and in this way the benefits derived in one shop would be passed on to all the shops coming within the sphere of the study. One of the chief values of this plan would be that a certain number of employees would gain first-hand knowledge of the work and would have a chance of expressing their views of any changes that might be recommended that would affect the employees. These objections would receive due consideration and for this reason all employees would more readily accept any changes in method that might be adopted.

I have also read with interest the editorial on page 683 entitled "Training the Foreman." To my mind the foreman is the key to the whole problem of efficiency and safety. Every large shop at least should provide a definite and systematic training course for all of its foremen. This work should have a competent instructor in charge of it, and the course of instructions should not only provide courses in the mechanical details of the foreman's work, but should be designed to develop executive ability and give the foreman a larger outlook on the transportation business as a whole.

This work should also be under the general supervision of a personnel department.

J. C. Clark,
Asst. to General Manager in Charge of Safety, Oregon Short Line.

Save Fuel by Keeping Valves Square

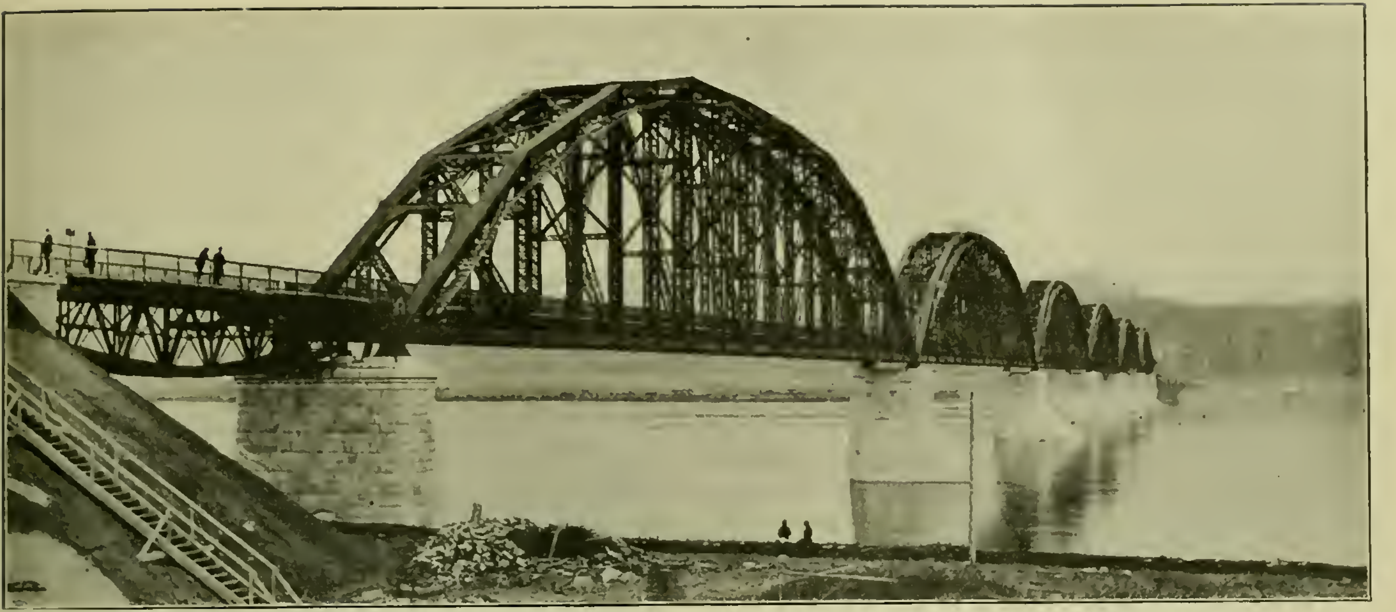
Heath, Mass.

To the Editor:

Why is not valve setting given more attention in large engine terminals? Much money is spent, and rightly too, on the upkeep of devices for economy in the production of steam but little attention is given to the device that determines the economy secured in the use of steam; namely, the valve gear. With pooled engines, very often a locomotive out of square will not be reported as requiring attention in that respect, or an engine may be out of square and yet handling its train all right and so nothing is done. Then there is the rarer case of an engine sounding square but in reality being out.

The effects of a lame engine on fuel consumption are so well known that it is unnecessary to repeat them. But a point often not realized is the tendency of a lame engine to slip. This results in difficulty in starting and liability of stalling on a hard pull. The valve setting should be checked on each engine regularly. In the larger terminals, a valve setter and helper could probably be kept busy squaring valves. An engine should be inspected after perhaps 20,000 miles. In a good many cases where there is much lost motion and the engine has considerable mileage to cover before the next visit to the back shop, it would pay to renew bushings in the valve gear and thus have the valve move as intended and not lag.

W. G. Landon.



Bridge on the Tomsk Railway Crossing the Yenisee River at Krasnoyarsk

Mechanical Equipment on the Tomsk Railway

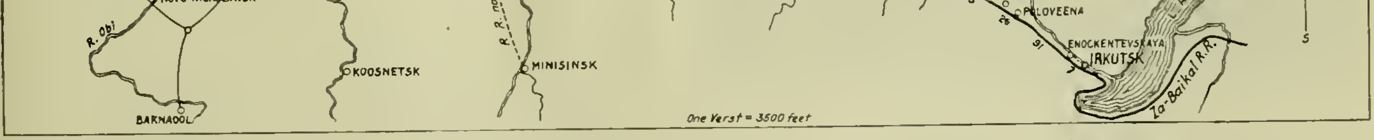
An American's Impressions of the Locomotives. Cars and Shops of the Trans-Siberian System

BY JAMES GRANT
Late Captain, Russian Railway Service Corps

THE Tomsk railway is that part of the Trans-Siberian system, between Irkutsk and Novo-Nickoliavsk. The main line is all double tracked, a distance of 1,734 versts. As one verst is 3,500 ft., this is, in English units, approximately 1,156 miles. There are very few branches, the most important being the branch from Tiaga to Tomsk, about 80 versts long. There is a line in course of construction from Achinsk to the city of Minisinsk. By glancing at the map of the railroad it will be observed that Achinsk, which is a small town, is about 170 versts west of Krasnoyarsk, while Minisinsk is an important city about 250 versts south of the railroad, on the Yenisee River. This latter city was always a Bolshevik stronghold, an army of 15,000 being stationed there all the time that the Kolchak forces controlled Siberia. The Kolchaks were never able to oust them from Minisinsk because the town was too far away from all transport facilities. The road connects with the Za-Baikal at Irkutsk and the Omsk Railway at Novo-Nickoliavsk.

The section through which the Tomsk railway runs is perhaps the most fertile and productive region in all Siberia. The scenery along the road is very pretty, consisting of fine agricultural districts, coal mining concessions and dense forests. The road crosses great rivers and runs directly through the wealthy Yenisee province. This province was always known as one of the most independent in all the old Romanoff's broad domains. Considering the past years of revolution, the roadbed is in excellent condition; it is all ballasted and has 72 lb. rails. The section work at the time the American forces were in Siberia was done mostly by women, nearly all men of fighting age being engaged either with the old Russian army or the Bolsheviki.

This sector of the country has been the scene of much



Map of the Tomsk Railway Showing Distances in Versts Between Principal Stations bloody strife since 1917, the Czecho-Slovak forces and Bolsheviki having many pitched battles all along the right of way. As a result many fine bridges have been blown up, tracks torn up and many station buildings wrecked. In May, 1919, the station at Tyshet, one of the main terminals, was practically blown away after a battle between Czecho-Slovaks and Bolsheviki, approximately 200 Reds being annihilated in this struggle. While the writer was stationed at Krasnoyarsk he saw seven train wrecks between that station and the next terminal in one week of September, 1919. These wrecks were all caused by Bolsheviki pulling out rails, usually wrecking Russian military trains, resulting in much damage to the motive power and invariably causing quite a loss of life. At this time there is a sad collection of equipment in the ditch, awaiting some semblance of order so that it can be brought to the shops and be rebuilt.

The Tomsk railway has always been recognized as the banner railroad in Siberia, especially in regard to mechanical equipment. The road has seven main terminals, with seven turn-around terminals located between. The terminals and verst posts are as follows:

Irkutsk (Terminus of Za-Baikal Railway)	0 v.
Enockentevskaya	7 v.
Poloveena	98 v.
Zeema	235 v.
Tooloon	366 v.
Nishni-Udinsk	475 v.
Tyshet	628 v.
Elanskaya	757 v.
Kluckvennaya	896 v.
Krasnoyarsk	1,020 v.
Chernorechenskaya	1,154 v.
Bogotol	1,256 v.
Marinsk	1,386 v.
Taiga	1,520 v.
Bolotnaya	1,616 v.
Novo-Nickoliavsk (Terminus of Omsk Railway)	1,734 v.

The stations shown in italics are main terminals.

Elanskaya is the station at which Colonel Blunt and six other American engineers were captured by the Bolsheviki while endeavoring to evacuate eastward towards Vladivostok in January, 1920. The writer left Colonel Blunt and his party at Krasnoyarsk on December 19, 1919, and it took seven weeks to make the trip to Vladivstok, a distance of 4,036 versts. The remainder of the engineers started evacuation eight days later, but only got as far as Elanskaya, where they were captured. They were, however, later turned over to the Czecho-Slovaks, who had their echelons strung out all along the line, trying to get to Vladivostok.

A Train at Vladivostok Station

Terminals

Each of the main terminals on the Tomsk railway is well equipped, usually having large and commodious yards. The engine houses generally consist of two rectangular sheds with capacities for about 50 locomotives, a rectangular shop for nine engines (in which all light repairing is done), machine shop and blacksmith shop. The engine sheds are equipped with drop pits and hydraulic traversing rams for dropping wheels. One fine feature is that the drop pit rails all swing on hinges, so that when dropping wheels there is no lifting of heavy rails. All shops are equipped with electric hoists of the same type as used in the main shops and described later in this article.

Main terminals have both a turntable and a "Y," while turn around stations have a "Y" only. Turntables are operated by an ingenious air device, connected to the train line on the engine or tender. This consists of a horizontal air cylinder with a clamp attached to the piston, so designed that it seizes and releases the rail, as controlled by the operator with a three-way valve. This device, while probably not as good as some of the air driven attachments in this country, works surprisingly well and extreme cold weather causes it very little trouble.

Station at Pograneechnaya, Showing Type of Freight and Passenger Equipment

Motive Power

The road has between 500 and 600 locomotives in operation, and these engines are composed of seven distinct types only, as follows: 1. 0-6-0 or Switcher type. This is the so-called government type of locomotive, so common in Russia. These engines were built in 1893 and 1896 by the Putilov works of Petrograd. There are only a few of this type on the road and they are used for switching service. The principal dimensions are:

Weight on drivers	34.50 tons
Total weight, engine and tender, loaded	60.10 tons
Diameter of drivers	1,292 m.m. (52 in.)
Length of engine and tender, overall	14,313 m.m. (47 ft. 0 in.)

2. 0-8-0 or Eight Wheel Switcher. The road owns about 200 of this type. Most of them, however, are stored away out of service, replaced by more modern power. They were built at different times, between the years 1895 and 1906, by seven different locomotive works in Russia. They are generally used for switching. The principal dimensions are:

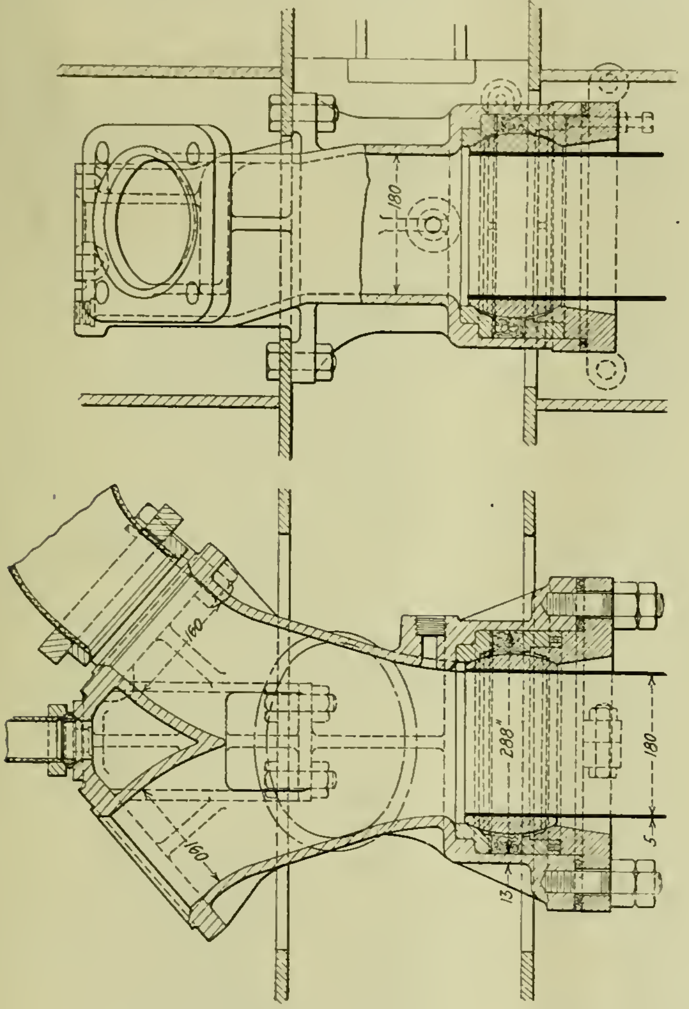
Weight on drivers	51.5 tons
Total weight, engine and tender, loaded	103.03 tons
Diameter of drivers	1,200 m.m. (47.3 in.)
Length of engine and tender, overall	18,691 m.m. (61 ft. 5 in. app.)

3. 0-6-6-0 Mallet Articulated. The road owns about 230 of this type of locomotive, which is one of the most successful for freight service on the whole Trans-Siberian system. Although not so large as our American Mallets, yet they have many noteworthy features. These engines were built between 1899 and 1906 by the Bransk, Putilov and Kolomensk locomotive works. They have slab frames (as have all Russian built locomotives) of 1¼-in. plate, and breakage is a thing unknown. The high and low pressure engines are connected by upper and lower steel castings; riveted to the frames, and hinged on two 4½-in. pins, brass bushed. The driving box jaws are bolted or riveted to the frames, so that they can be removed and machined, when the engines undergo repairs. The driving box shoes and wedges are made of steel, while

the box faces are brass lined. The receiver pipes have both ball and sleeve joints of special construction, as shown in the drawings, which are so designed that there is little trouble from steam leakage. The engines have Walschaert valve gear, piston valves, fire boxes and flue sheets all made of copper, with copper stay bolts, and a special type of Freidman injectors. The principal dimensions are:

Weight on drivers	84 tons
Weight of engine and tender, loaded	135 tons
Diameter of drivers	1,200 m.m. (47.3 in.)
Diameter of H.P. cylinder	475 m.m. (18.7 in.)
Diameter of L.P. cylinder	710 m.m. (28.0 in.)
Diameter of H.P. and L.P. piston valves, both	300 m.m. (11.8 in.)
Length of stroke	650 m.m. (25.6 in.)
Maximum steam pressure	12 atmospheres (176 lb. per sq. in.)
Length of engine and tender, overall	21,097 m.m. (69 ft. 3 in. app.)

4. 2-4-4-0 Mallet Articulated (used for passenger service). The road has 112 locomotives of this type built between 1903 and 1909 by the Kolomensk Locomotive Works. These engines are quite similar in design to the freight Mallets, and can get over the road with remarkable speed. The principal dimensions are:



Tee and Ball Joint on Receiver Pipe of Russian Mallet

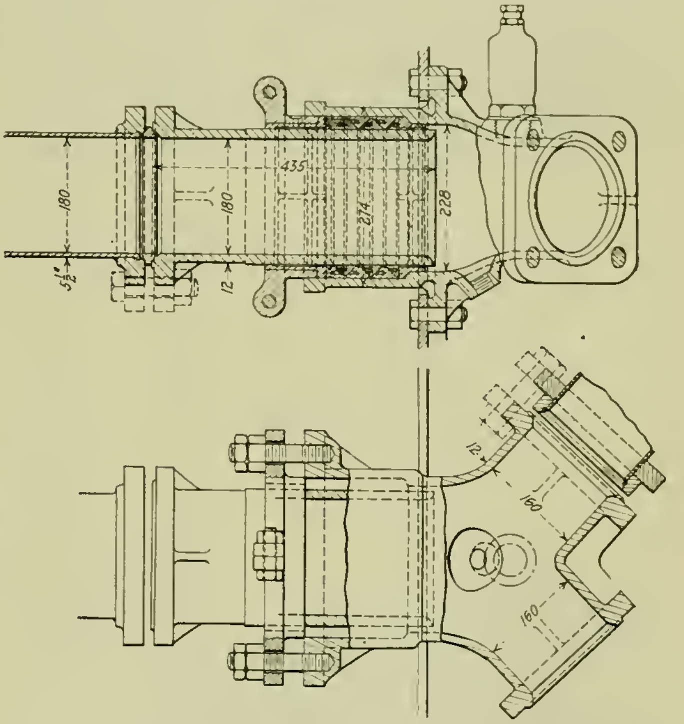
Weight on drivers	65 tons
Weight of engine and tender, loaded	116.07 tons
Diameter of drivers	1,350 m.m. (53.2 in.)
Length of engine and tender, overall	19,723 m.m. (64 ft. 9 in. app.)

5. 2-10-0 American Decapod (built by the Baldwin and American Locomotive Works between the years 1913 and 1916). The road possesses about 50 of these engines. Their tonnage on the Tomsk railway is rated just the same as the freight Mallets. They have a Schmidt superheater and carry a steam pressure of 12.7 atmospheres (187 lb. per sq. in.). A description of these locomotives has appeared in a former issue of the *Railway Mechanical Engineer**. Many of this type, built for the Russian government, are now operating in this country.

6. 2-6-2 or Prairie type (used in passenger service). The road has 13 of these locomotives, built in 1915 by the Sormov Locomotive Works. These are a fine passenger engine and compare favorably with any of our American power. Equipped with Walschaert valve gear, and Schmidt superheaters, carrying a steam pressure of 13 atmospheres (191 lb. per sq. in.) they are capable of great speed. They have a special design of piston rod packing, using a double packing ring. Officials claim that this packing runs from shopping to shopping, without renewing. It seldom blows even in the coldest of weather. The principal dimensions of this class are:

Weight on drivers	47.1 tons
Weight of engine and tender, loaded	126.3 tons
Diameter of drivers	1,830 m.m. (72.1 in.)
Length of engine and tender, overall	21,271 m.m. (69 ft. 11 in. app.)

7. 4-6-0 or 10 Wheel type (used in passenger service). The road has 44 of this type, built in 1910 and 1911 at the Kolomensk and Putilov works. They are quite similar in design to the Prairie type being equipped with Walschaert valve gear and Schmidt superheaters and carrying a steam pressure of 12 atmospheres (176 lb. per sq. in.). The principal dimensions are:



Slip Joint on Receiver Pipe of Russian Mallet Locomotives

Weight on drivers	46.5 tons
Total weight, engine and tender, loaded	124 tons
Diameter of drivers	1,700 m.m. (67.0 in.)
Length, engine and tender, overall	19,689 m.m. (64 ft. 8 in. app.)

An engine crew consists of three, an engineer, assistant engineer and fireman. Many women now work as firemen, there is such a scarcity of able-bodied men. The engineers as a rule are bright, capable fellows, highly trained in their occupation. It is a rule that all engineers running a locomotive, must first serve an apprenticeship in the shops so they are thus taught the repairing and upkeep of locomotives. Afterwards they graduate as firemen, assistant engineers, then first engineers, an examination being necessary before being promoted to a higher grade. The statistics often given that 60 per cent of the Russian working people are illiterate certainly does not apply to the railroad workers.

A train crew usually consists of about five men, a chief

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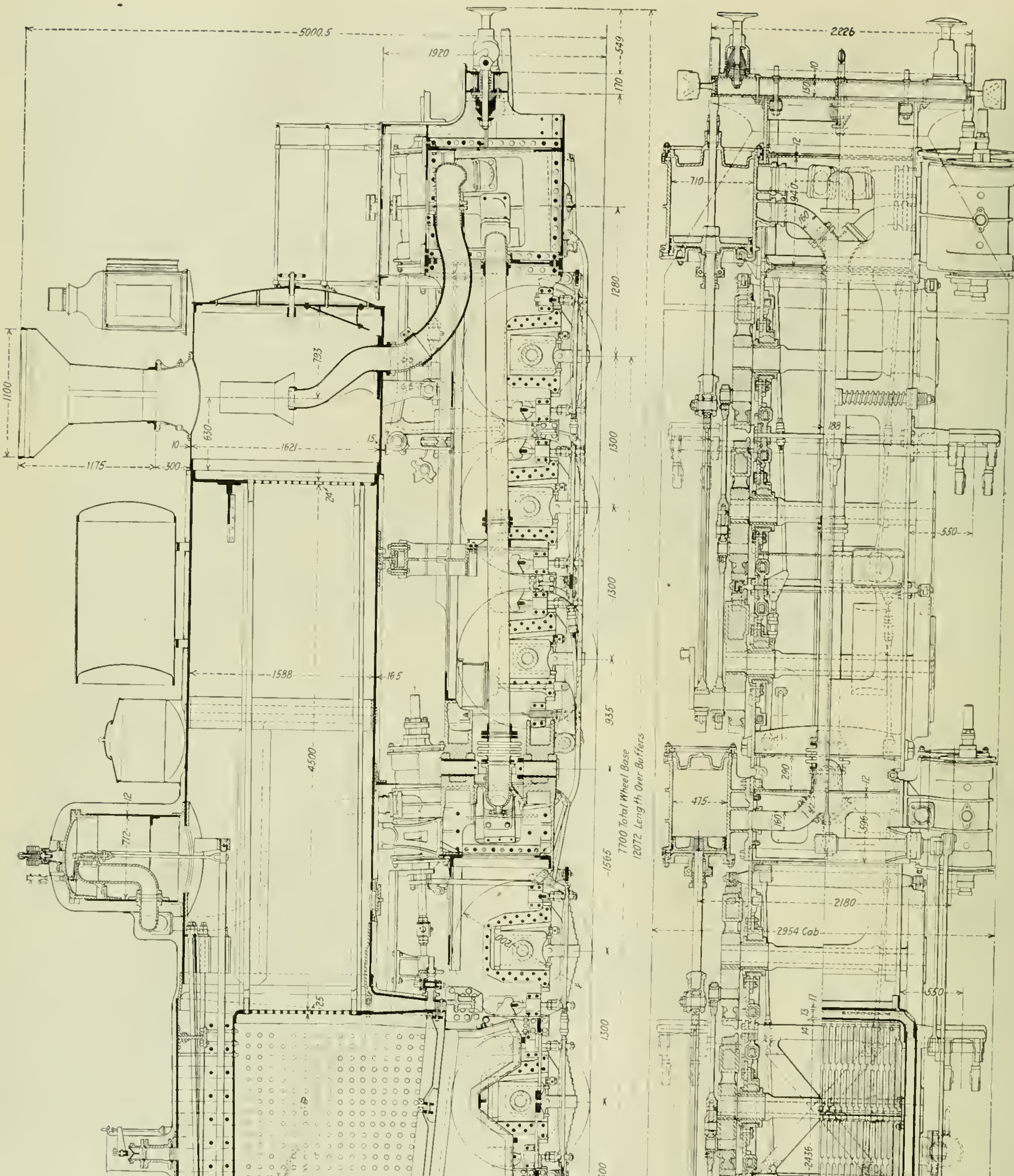
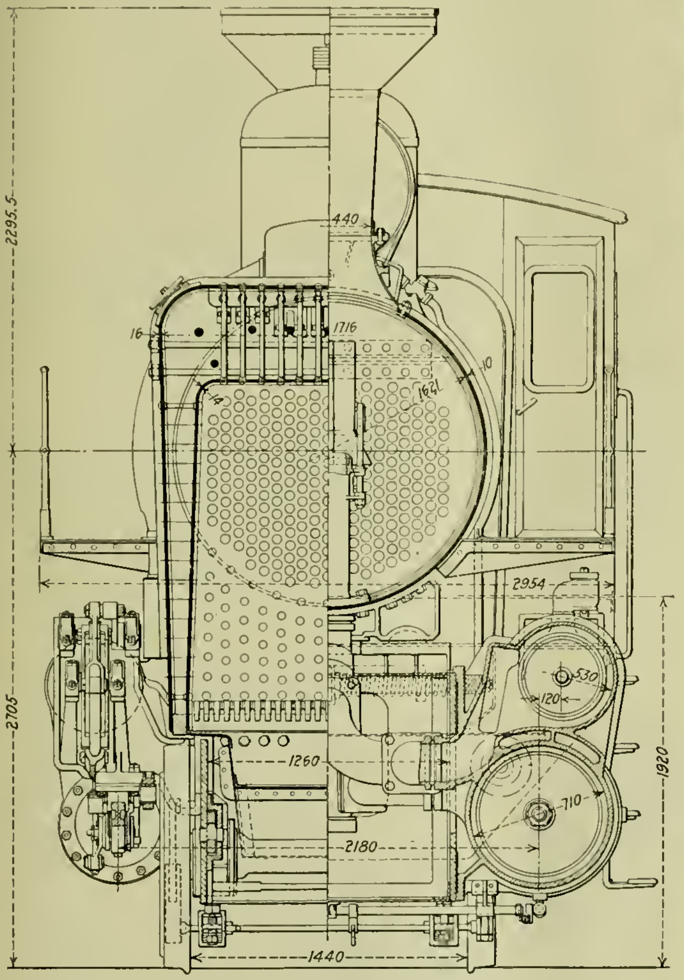
*Issue of October, 1917, page 545.



Elevation and Plan of Russian O-6-6-0 Mallet Freight Locomotive. (All Dimensions In Millimeteres.)

conductor and four assistants. This number, however, varies according to the tonnage of the train. There are no air brakes on the freight cars, hence about every tenth car is required to be a brake car, and is manned by one of the assistant conductors. The tonnage of the usual train is 60,000 poods, or about 1,000 tons. On certain sections of the road helper engines are necessary, but the grades as a rule are very slight. Riding these open brake cars in winter is a strenuous occupation. Quite frequently the thermometer goes down to 60 degrees below zero and stays there for months. The road furnishes brakemen with big fur lined coats and high felt boots, which are very necessary for the Siberian winters.

The rolling stock is the usual type of equipment seen in Russia. Passenger coaches are divided into first, second, third and fourth classes. Passenger coaches are much run down on account of lack of attention, the provodnecks or porters being lazy and discipline lacking. Coaches are all built with coupes to accommodate two or four people, and a corridor runs along one side.

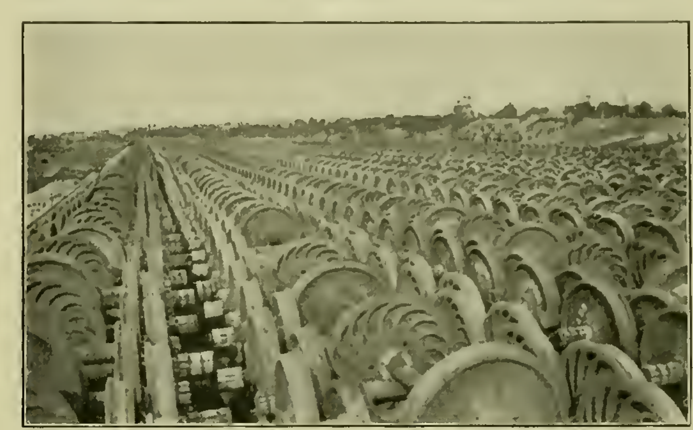


Cross Section of Mallet Freight Locomotive, Tomsk Railway

The freight equipment consists mostly of tepluskas or four wheeled box cars, with a capacity of 1,000 poods or 16 tons, all with turnbuckle couplers. However, many of the American 3,000 pood or 50 ton gondolas are now in operation on this road, and it is doubtless only a question of a few years when the small cars will be superseded by those of larger capacity.

Fuel is obtained from two different sources located near each end of the road. Large coal mines are operated at Cheromkovo, shown on the map about 100 versts west of Irkutsk and near Tiaga, about 200 versts east of Novo-Nickoliavsk. A good grade of lignite coal is obtained, and there is a plentiful supply at different points along the road, although only these two sources are worked by the railway. It was at Cheromkovo that the Social Revolutionary party sprung up in December, 1919, which overthrew the Kolchak regime in Siberia.

The main office of the road is located at Tomsk, on a branch of the railroad. It seems a peculiar place for the office and the advisability of moving it to Krasnoyarsk on the main line has often been mooted. During the Bolsheviks' short tenure in 1918, the moving of the main office was one of the things contemplated. The office is located in two or three different buildings, with a multiplicity of employees, something over 2,000. The Russians have a splendid system of records, and to keep up this system requires countless help. They are highly technical in everything, the officials of the roads being graduates of some of the best European technical colleges. There are very few important railway positions in Russia held by anyone except graduates of some technical college.



American Car Wheels Stored at Osgulnaya, 40 Miles from Vladivostok

Tomsk is the seat of learning of Siberia, and is the location of the famous Tomsk University. It is the ambition of all the better class Russians to graduate through this school. The university has a fine mechanical institute and many engineers graduate there. The city is one of the prettiest in Siberia, being built on the banks of one of the tributaries of the Obi river, which is navigable to the Arctic Ocean.

Snow Plough Commonly Used on Russian Railroads

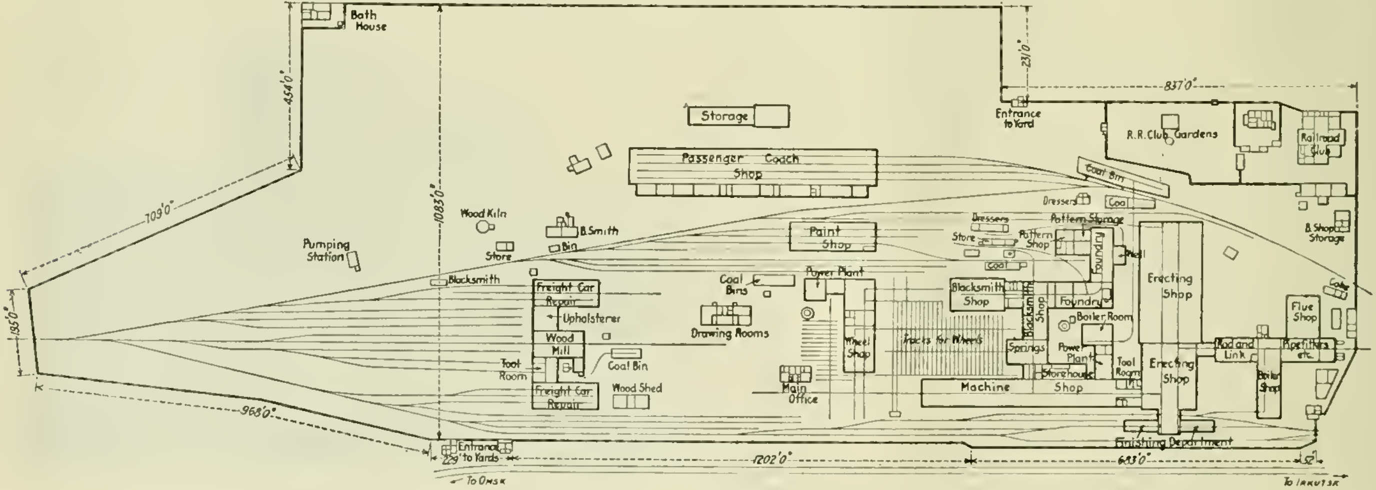
The Krasnoyarsk Shops

The main shops of the road are located at Krasnoyarsk and are undoubtedly the largest repair shops in Siberia. Krasnoyarsk is an important commercial city with a population of about 100,000 and is built directly on the banks of the great Yenisee river. This immense river, from its source in Mongolia, winds its way north to the Arctic Ocean. The railway bridge across the river at this point is a magnificent structure, 400 sagenes or 2,800 ft. long, built in six spans. The river is navigable by steamboat to the ocean, but only for a few months in the year.

The shops have always been recognized as among the most progressive and efficient in all Russia. During the past years of revolution this plant has been the scene of much turmoil, and one really wonders how it has performed its functions so well. In 1918 the whole roof of the erecting shop was burned, supposedly by the Bolsheviki. Practically deprived of all sources of supply for the past five years, the shops have managed to keep the condition of the power about normal, and when the writer was there in 1919 their statistics showed that engines on the Tomsk railway were really up to their normal standard of peace times. The only engines clogging up the shop were those from European Russia evacuated by the Kolchak government in their retreat before the Bolsheviki.

The superintendent of shops (if he has not been removed by the Bolsheviki) is a clever Russian engineer, Mr. Korkin. A superintendent's position is no sinecure in a large plant in Russia, grievances being in front of him practically all the time. The employees have always had so many special privileges granted them by the government railways that a superintendent must be endowed with exceptional administrative abilities.

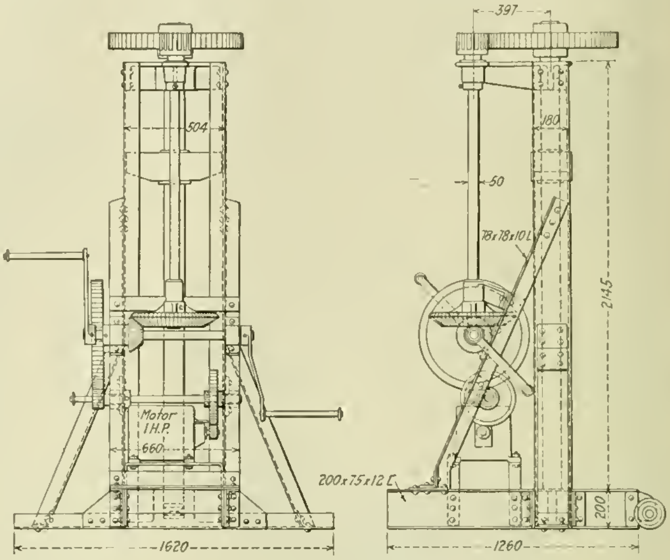
The drawing will give some idea of the extent of this plant. The erecting shop is a substantial brick building 464 ft. long and 154 ft. wide, with a high roof. An electrically driven transfer table runs up and down the center of the shop. There are 44 locomotive pits, 22 on each side of the transfer table. Tenders are also repaired in the erecting shop. Locomotives are raised by ingenious electric hoists, which are portable and can be moved to any pit. Four of these hoists are usually required to raise a locomotive, two at each end with structural iron beams across the pit. One of the drawings shows the general design of these hoists. They are operated by a one horse power direct current motor geared at a ratio of about 20 to 1. All main terminals on the road are also furnished with these hoists, which make heavy repairs considerably easier. A locomotive can be raised high enough to take out wheels in about ten minutes. The shop is served by four 5-ton overhead electric bridge cranes, which are quite suitable for all requirements. At one end of the shop is a building known as the finishing shop, to accommodate two engines. When an engine nears completion it is taken to this shop, fired up and tested before going on its trial trip.



Arrangement of Tracks and Buildings at Krasnoyarsk Shops

All necessary departments are accessible from the erecting shop without going out of doors, a great advantage in the extremely cold winter weather.

The machine shop, which is located directly off the erecting shop, consists of a long narrow building 528 ft. long and 63 ft. wide. There are a great number of machines in this building, and it is very crowded, but work is taken away as soon as finished, thus relieving matters. The machines are mostly of Russian or German make; there are very few American tools in this part of the world. Two new bolt cutters arrived at the plant in December, 1919, and these were the only American machines. The machines are arranged in groups and driven by electric motors. Since the war the shops have had to make all their small tools, such as taps, dies, reamers and drills, and this work keeps many machines busy. Tool steel was also at a premium, and in 1918 and 1919 this shop was forced to use tire steel as a substitute, in order to keep the wheels turning. Crossheads had to be forged here, as no steel castings were available. This was a costly operation, something over 80 hours' machine work being necessary on these forgings.



Locomotive Hoist Used on the Tomsk Railway, Operated by Hand or by Motor

The blacksmith shop is located in two buildings joined to the machine shop. Both are well equipped with steam hammers, but are in great need of forging machines. They have been forced to make nuts, bolts and rivets, which in pre-war days were bought from the factories, and there is no special machinery for this work.

The foundry, which extends out from the blacksmith shop, consists of two main buildings, one building for small work and one for large work served by a 5-ton overhead electric traveling crane. All the cylinders are cast here and all stock supplies for the road. There is also a brass foundry in connection. The pattern shop is an integral part of the foundry.

East of the erecting shop is located the rod and link department. There is a very fine type of link grinder in this department, a German invention. Rods are very thoroughly and systematically overhauled, although much unnecessary filing and polishing is performed.

The main boiler shop is a building 200 ft. long by 56 ft. wide. It is served by a 30-ton overhead electric bridge crane, which is sufficient for lifting any of the boilers. As the building has a high roof, one boiler can easily be lifted over another. They are equipped with the usual boiler shop machinery, including bending rolls, two radial drills, two lathes and double-ended punch and shears. The main deficiency is lack of air equipment, so that much of the work must be done by hand. The stay bolt drilling is efficiently taken care of by portable electric drills, and these machines can be used in almost any place around the boiler. During the stay of the American engineers, the plant was laid out for air equipment, but the compressor and tools did not arrive before the occupation by the Bolsheviki. There is a great future for air tools in Russia.

The first thing that strikes an American on entering a boiler shop in Russia is the great amount of copper used. All Russian built engines are equipped with copper fire boxes, flue sheets and stay bolts. This entails great expense, but there certainly is very little boiler trouble on the road, leaky flues being quite a rarity. However, very good water is available over nearly the whole Trans-Siberian system.

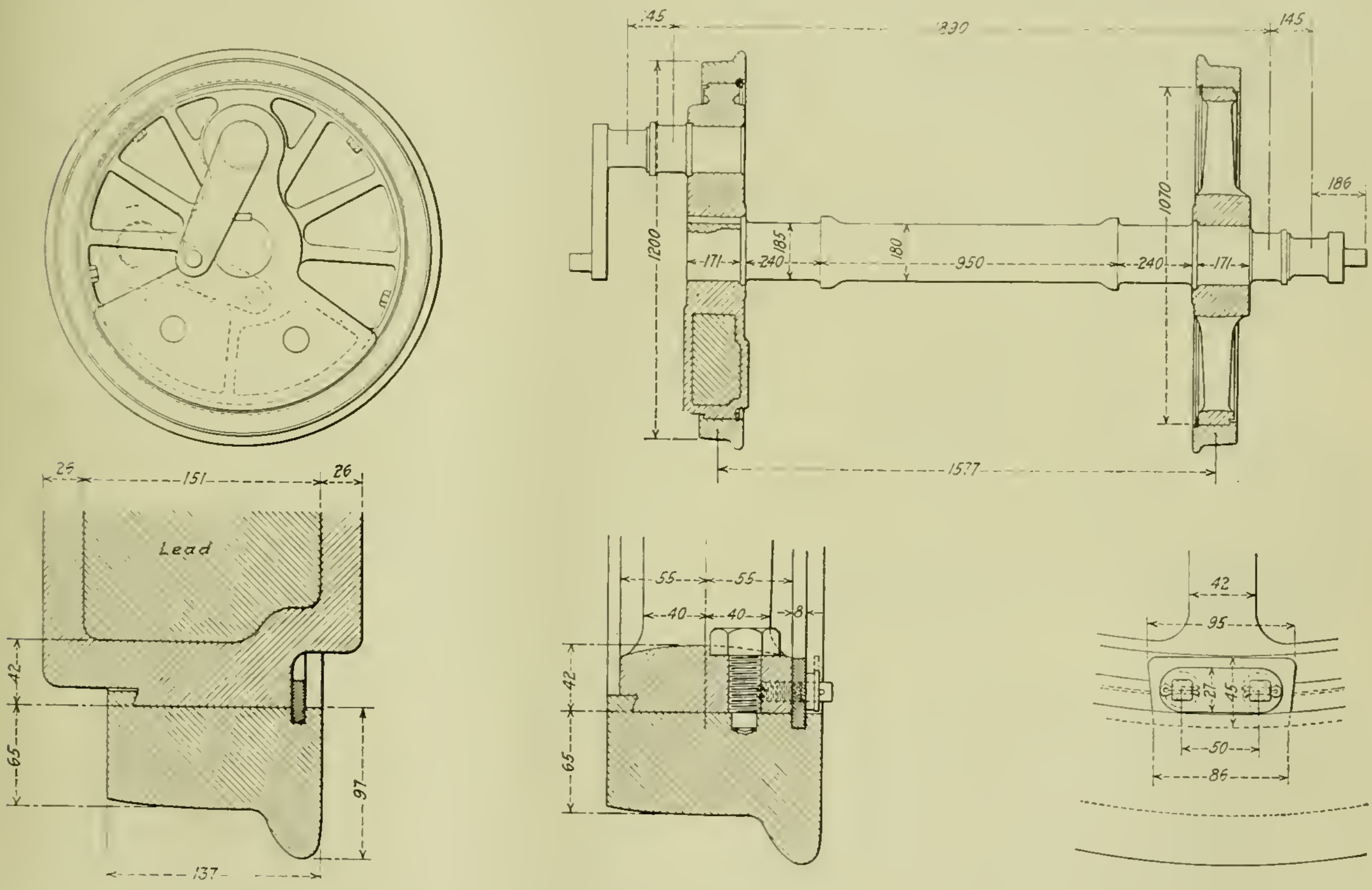
The flue shop adjoins the boiler shop. The tubes are well taken care of, the tips being welded by power driven rollers, and the flues cut off by a friction saw. The flue rattler is a motor driven cylindrical cast iron drum, similar to many of our older types.

The wheel shop is a neatly arranged building, served with overhead electric traveling cranes. The wheel lathes, which are all Russian built, are strong, powerful machines, equipped with two back and two front compound slide rests. They have been badly handicapped, however, for the past few years for lack of tool steel. The shop has a fine type of quartering machine, specially designed for main pins on Russian locomotives. On the Siberian roads crank arms are all forged solid with the pin, so it is a difficult matter to machine these pins without special tools.

Tires are changed by up-ending the wheel centers, using coal burners for heating. Oil is too precious a thing at this time in Siberia, hence the shops are forced to use coal. Oil was formerly obtained from the south of Russia, but since the revolution this source has been shut off and oil for the road is now obtained through Japanese firms.

The paint shop is a building capable of holding about 20 passenger coaches.

The main car shop is a large building, 606 ft. long by 85 ft. wide, with four tracks running the full length of the building. This gives ample space, so that it is seldom necessary for men to work outside in severe weather. An annex runs along the whole length of this building, in which are located the different departments necessary for coach work. There is a very modern nickel plating room in this building, which takes care of all utensils for dining cars, coach trimmings and other articles.



Russian Design of Driving Wheels, With One-Piece Pin and Return Crank and Tire Retaining Devices

Two other car shops, each 161 ft. by 63 ft., serve for repairing freight cars. The planing mill is located between these two shops and is equipped with an average amount of wood working machinery.

The shops have their own power plant, which contains two d. c. generators for power and one a. c. machine for lighting. The boiler room is a poor lay out, having a mixture of locomotive type boilers and return tubular boilers. All coal and ashes are handled by hand labor, no mechanical devices being installed. There is another auxiliary plant with six return tubular boilers, used only in winter for heating. All buildings are well heated by large steam radiators.

The general stores are located close to the shops and consist mostly of brick buildings. The stock at the time the American forces were there was much depleted. Before the war there was a standing order that a three years' supply of everything must always be kept on hand, and this foresight was about all that kept them able to run during the days of chaos. During the year 1919 the Allied Technical Board helped them greatly to obtain stock through Vladivostok. In normal times all steel, copper and metal goods came from the Ural mountains, while other supplies came from the interior of Russia. The stores department has a good system of keeping records of stock on hand at all times, but employs lots of help to do this.

Engines are repaired according to a well tabulated schedule, and when a locomotive makes the stipulated verstage, it is tied up and the work done as specified in the railroad's book of rules and repair laws.

In the following table is shown the assigned mileage for shopping engines:

FREIGHT LOCOMOTIVES

30,000 versts	Change of wheels
60,000 versts	Second change of wheels
90,000 versts	Medium repairs
120,000 versts	Third change of wheels
150,000 versts	Fourth change of wheels
180,000 versts	Capital repairs

PASSENGER LOCOMOTIVES

40,000 versts	Change of wheels
80,000 versts	Second change of wheels
120,000 versts	Medium repairs
160,000 versts	Third change of wheels
200,000 versts	Fourth change of wheels
240,000 versts	Capital repairs

The main shops do only the capital or general repairs, and what is known as accidental repairs. Changing of wheels and medium repairs are taken care of at the small shops located at each main terminal. Changing of wheels means the replacement of wheels with worn tires for another set and necessary repairs to driving boxes, machinery and so forth. Each terminal has always on hand a few spare sets of driving wheels and the worn ones are all shipped to Krasnoyarsk shops, where all wheel and axle work is taken care of. The law requires in Russia that all tires must have retaining rings, hence wheel and tire work is quite a large operation. The details of the tire fastenings are shown in the drawing of the wheels and axles.

Some details from the report of work at Krasnoyarsk shops for the years 1916-17-18 and '19 will prove interesting. In 1918 the plant was under Bolshevik control, and a glance at the figures shows that year as the lowest output of the four years, with the greatest number of employees. For example, during January, 1916, there were 1,389 mechanics and laborers employed and the output was equivalent to 7.92 general repairs of four-axle locomotives. In June, 1918, the force had been increased to 2,865, but the output on the same basis was only 1.13 general repairs. The cost of general repairs to locomotives increased 808 per cent from 1916 to 1918. Probably conditions may now be different, as it is a well known fact that the workers became intoxicated with their liberty during the early period of the Bolshevik regime in 1918.

One cannot but admire the quality of workmanship that is put on all repairs. Everything is put together to the closest possible working margin, the matter of expense not being considered. To the mind of the American engineer, too much time is wasted in ornamentation and elaboration; much unnecessary machine and finished work is put on equipment, when the rough article could just as well serve the purpose.

When an engine leaves the shops it must be able to go on the train, make the time, and pull full tonnage on the first trip, or is not accepted by the operating department. This usually necessitates quite a few trial trips before finally leaving the shops, and it is no unusual thing to see the engine raised off the wheels, boxes taken out and refitted between these trips. Diagrams and tests are also made by the mechanical engineers, to be sure that the engine can give the maximum efficiency. The locomotive must be passed as O. K. by trial and inspection before being finally turned over for service.

Taking past conditions into consideration, it is remarkable how well the motive power and rolling stock have been kept up. The next few years will undoubtedly show great changes. The 1,000 pood (16 ton) box cars will likely be replaced by the larger type of American box cars and gondolas. At Vladivostok, American cars were being assembled just as fast as the plant at First river could turn them out, and these cars were getting to be quite numerous on the Trans-Siberian.

Undoubtedly a heavier type of locomotive will also be built in the near future. The roadbed is excellent and bridges are all built with a high enough factor of safety to carry any weight of locomotive we have in America today. The wide gage of five feet is also a good argument in favor of heavier equipment.

There is great opportunity for American ideas and industry in Siberia; now that the embargo has been lifted, let us hope that soon satisfactory trade relations can be established between both countries. The Russian people have a warm feeling for the Americans and have a great craving for American goods.

The writer had 27 months' experience on the Siberian railways and during that period has met many of the leading mechanical engineers on the various systems there. They are all courteous, intelligent and highly trained men. Most of these officials talk either French or German, but it is a rarity to find one who speaks English. If we are to become connected with them commercially, we must study their language. At first it is quite difficult, there is so much difference in the alphabet, but it is absolutely phonetic and can be learned by diligent study. The Russian people have been the victims of circumstances for some years now, but we trust their dark days are nearly over, and that they may soon emerge from their chaotic condition. The rest of the world needs a real Russia; and it is to be hoped that they may not be disappointed.

ACCIDENT BULLETIN 74.—The Interstate Commerce Commission has issued Accident Bulletin No. 74 containing the record of collisions, derailments and other accidents on the railroads of the United States for the last quarter of 1919 and also the tabular statements for the twelve months ending with December. Remarkable decreases are shown in many items, as compared with 1918. In the twelve months of the year now reported, 110 passengers, 366 employees and 41 other persons were killed in train accidents, and 4,549 passengers, 3,202 employees and 124 other persons were injured; as compared with a record in the preceding year of 286 passengers, 554 employees and 156 other persons killed and 4,655 passengers, 4,250 employees and 500 other persons injured.

The Locomotive Terminal an Operating Factor*

Best Use of Terminal Facilities Dependent on Organization, Supervision and Good Management

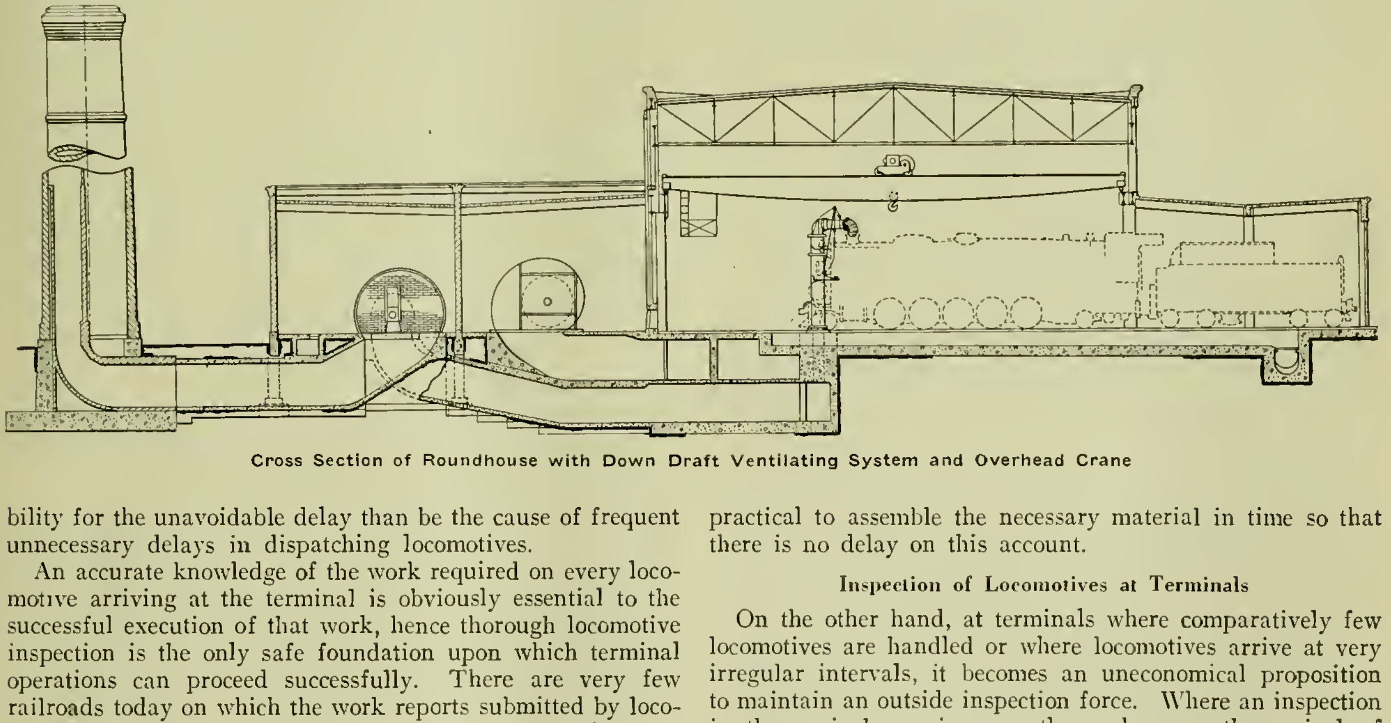
BY L. G. PLANT

Associate Editor of the Railway Mechanical Engineer

WHILE it would be as impossible to prescribe any fixed mode of terminal operation as to describe equipment that would be universally applicable, there are certain operations in the terminal that are fundamental. Moreover, all terminal operations should proceed with as great regularity and as much expedition as possible.

Operation of Locomotive Terminals

Terminal operations constitute an unwritten page on every time table and should be conducted accordingly. The habit of waiting until repairs are actually completed before advising the transportation department that the locomotive is available for service cannot be too strongly condemned. The time at which a locomotive will be available for service should be anticipated as far as possible and the transportation department notified accordingly. It is better to assume responsibility for the unavoidable delay than be the cause of frequent unnecessary delays in dispatching locomotives.


Cross Section of Roundhouse with Down Draft Ventilating System and Overhead Crane

An accurate knowledge of the work required on every locomotive arriving at the terminal is obviously essential to the successful execution of that work, hence thorough locomotive inspection is the only safe foundation upon which terminal operations can proceed successfully. There are very few railroads today on which the work reports submitted by locomotive engineers can be depended upon as a reliable index to the work to be done. Enginemen cannot be relieved of the responsibility for a locomotive condition report and something might be said in favor of educating the engineers to submit a more intelligent report but as matters stand the most careful inspection of arriving locomotives must be made.

More might be said in favor of educating air brake and other inspectors responsible for inspecting locomotives upon arrival at the terminal. Frequent changes in the personnel of the inspection force and appointment on the basis of seniority are bound to result in a certain amount of incompetence in the inspection of locomotives. The railroads will surely be held responsible in the event of accidents resulting from incompetent inspection and if they cannot always pick trained men for this work, should see that instruction of some sort is available to these men. The air brake instruction car should not only be available to every air brake inspector, but these men should be subject to certain examinations that will serve to establish their competence.

Inspection may either be conducted immediately upon arrival or as soon as the locomotive is placed in the house. Where locomotives are arriving at frequent evenly spaced intervals throughout the day, the system of outside inspection in covered pits has very great advantages. The delay over the inspection pit should not average in excess of 15 minutes and a statement of the work required of each gang foreman may be available before the locomotive has actually been placed in the house. Moreover, an advance report in regard to the condition of the locomotive frequently makes it more practical to assemble the necessary material in time so that there is no delay on this account.

Inspection of Locomotives at Terminals

On the other hand, at terminals where comparatively few locomotives are handled or where locomotives arrive at very irregular intervals, it becomes an uneconomical proposition to maintain an outside inspection force. Where an inspection in the enginehouse is promptly made upon the arrival of every locomotive there can be no serious objection to this method. In fact, there is frequently a great advantage to conducting inspection in the enginehouse since it is frequently practical and economical to have inspectors make repairs on certain classes of defects. Locomotive inspection should be subdivided as far as possible. Excellent results are often obtained from assigning one inspector to certain defects that have been causing serious trouble. For instance, it is the practice on one railroad that has made a conspicuous success of Mallet locomotive operation, to assign one mechanic and assistants at each terminal during the winter months to inspect and repair steam leaks exclusively.

One of the most remarkable examples of intensive terminal operation in this country is accomplished by departing boldly from the conventional routine. Approximately 170

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*From a paper presented before the New England Railroad Club on November 9, 1920. An abstract of the first part of this paper was published in the December issue of the *Railway Mechanical Engineer.*

locomotives are handled through this terminal each day and as each of these locomotives arrives it is first subjected to the most thorough inspection. There are three parallel inspection pits under the direction of a foreman inspector. The number of men and the facilities at this inspection point are such that many light repairs can be executed during the time that the inspection is being completed. Upon the basis of the reports made by each of the principal inspectors, the foreman decides whether the character of repairs necessitates placing the locomotive in the enginehouse. Where the repairs are not of a heavy nature and do not require the services of a drop pit or crane the locomotive after passing over the ash pit is routed directly to a longitudinal repair shed. This shed covers two parallel track pits approximately 400 ft. in length. The building is of concrete and steel sash construction and the illumination, both overhead and in the pits, is very complete. The work at this repair shed is under the direction of an assistant roundhouse foreman and the number of mechanics employed is equal to any emergency. Moreover, the stores department have erected special facilities to provide for the material requirements at this point. While the work in this light running repair shed is conducted with the same degree of system and thoroughness as should characterize roundhouse work, it will readily be appreciated that these repairs can be executed far more expeditiously under the circumstances than were it necessary to place each locomotive in the enginehouse. In fact, it would be practically out of the question to handle 170 locomotives in and out of a 30 stall roundhouse each day and the general plan adopted at this point is one that might well be put into effect at other points where fewer locomotives are handled.

Locomotive Terminal Organization

Any consideration of the locomotive terminal as an operating factor must take into account the organization of the terminal. This is just as essential in the make-up of the terminal as the physical equipment. In fact the usefulness of this equipment depends wholly upon the extent to which its potential possibilities are developed. The most elaborate terminal equipment will be of little value to the railroad if we do not have men who know how these facilities can be used to the best advantage and who are on the ground to see that the equipment is so used. Nowhere on the railroad will the lack of organization show up more quickly than at the locomotive terminal.

Supervision is an essential element in organization; we must not only have men who can execute repairs promptly and handle locomotives expeditiously but we must have men whose duty it is to see that these things are done. In this connection we must clearly differentiate between mere system and organization. What I wish to infer is that organization in this case is more than a question of the number of supervisory officers, their titles or relative positions. It is entirely possible to have too many supervisors as well as too few, to reach a point where the organization becomes top heavy and each man becomes a cog in the wheel rather than an individual unit. It is particularly essential in terminal operation that individual initiative be fostered and that each foreman's authority and responsibility be as broad as possible.

The roundhouse foreman's position is not an office job and unless he is a live wire who is on the job every minute of the day and has the entire situation constantly at his finger tips, we cannot expect 100 per cent service no matter how elaborate the equipment. In this fact lies the only explanation I can offer for the phenomenon which we have all witnessed wherein the results obtained in a poorly equipped enginehouse with some boomer foreman are found to surpass the performance of a far better equipped terminal operating under the direction of a far more elaborate complement of supervisors.

The problem of getting and holding the type of men most needed for terminal operation is a serious one. When the railroad is fortunate in finding such men it must deal wisely and liberally with them. The proper course would be to develop material from within the ranks and it is not improbable that within a short time the railroads will see the wisdom of establishing central schools in which prospective foremen can be taught the rudiments of foremanship and be carefully examined in regard to all the details with which they should be familiar.

Locomotive Terminal Management

The problem of terminal management is very closely identified with that of organization because the strength of the organization depends greatly upon the character of the management. Constructive management can often develop excellent foremen out of the most unpromising material. On the other hand poor management which may be characterized by the lack of any broad fixed policy with respect to terminal operation or organization or failure to set any standard of achievement to which terminal forces may aspire, may deprive the railroad of some of its best talent.

It should be the policy of every railroad to establish a positive standard for every terminal and it is the duty of the mechanical officers who are responsible for terminal performance to see that these standards are lived up to. There are very few men who will not do better work and more work when it is known that this work will be subject to the most detailed scrutiny by superior officers. No matter how competent the foreman, the operation of any terminal can be improved by keeping a close check upon its performance. It is in this connection that the full value of statistical control must be appreciated. While there are no statistics which can be relied upon to take the place of a first hand knowledge relating to the condition of motive power from a maintenance standpoint, there is no question but that the operation of the average terminal can be accelerated by means of a daily operating report, without in any way impairing maintenance. In many instances a close check on the performance of the terminal has resulted in speeding up the movement of locomotives across the ash pit which is a clear gain so far as it concerns the time available for necessary maintenance.

The Value of Terminal Statistics

The efficacy of various reports dealing with the movements of locomotives at the terminals as a practical means for improving terminal operation has been questioned. Mechanical department officers who are critically inclined should bear in mind that the results of such reports not only indicate enginehouse detention but all terminal delays including those that are wholly chargeable to the transportation department It cannot be denied, moreover, that statistics of this character have served to focus attention on terminal movements and bring about improvements that might otherwise have been overlooked. Records relating to terminal movements have become very useful to progressive mechanical officers in demonstrating the relative efficiency of various features of terminal equipment. They have made it possible for a mechanical superintendent to estimate with reasonable accuracy the return that can be expected from an investment in a new ash pit or a boiler washing outfit. Statistics have served to demonstrate the extent to which use is made of the facilities available. With the assurance that existing facilities are being utilized to the utmost limit, executives have been encouraged to spend money towards improving these facilities.

There is undoubtedly a growing appreciation of the fact that the locomotive terminal is in reality an operating factor, that a block in the terminal may mean a block on the main line and that co-operation between the mechanical and operating departments must be the keynote to terminal management. Mechanical officials must realize that in their connection with the movement of locomotives through the terminal they are operating men in every sense of the word. Also operating officials should appreciate the fact that the locomotive terminal is not purely a mechanical facility identified with locomotive maintenance but a very important link in their main line.

Terminal Development Policies

In conclusion something should be said in regard to the policies that should be adopted toward locomotive terminal development. Being firmly convinced of the importance of the locomotive terminal as an operating as well as a maintenance factor on the railroads, it would appear to be the duty of every mechanical officer responsible for the performance of locomotive power to urge upon his superior officers the necessity for adequate terminal development.

It should be the policy of the railroads to maintain a proper relationship between locomotive and locomotive terminal development based on the safe assumption that the full value of a modern locomotive can never be realized in an antiquated terminal. One railroad might be cited as having made a conspicuous success of Mallet locomotive operation over long operating divisions because their terminal facilities were equal to the burden and because their terminal organization was trained to the task. On another railroad the absolute failure of well-designed Mallet locomotives can be ascribed largely to inadequate terminal facilities and lack of terminal organization.

If the problem were always as plainly understood it would not be so difficult to develop a proper policy. As it is, terminal development calls for foresight and the most discriminating judgment. Every expenditure for terminal improvement should conform to a broad comprehensive plan embracing ultimate terminal development so far as this can be forecast. The erection of an expensive concrete coaling station at some point where other facilities are inadequate and where terminal development along other lines must always be limited illustrates a pitiful lack of foresight. While the locomotive terminal cannot be regarded as a suitable dumping place for worn out machine tools from larger shops, there can be little excuse for going to the other extreme and buying a wheel lathe for terminal use that will turn a pair of tires in 45 minutes when the maximum requirement at that terminal will seldom exceed one set of tires per week. Undoubtedly many projects for locomotive terminal development are discredited by just such lack of foresight or failure on the part of mechanical officers to comprehend the purely business viewpoint that in the last analysis must dictate every good move in the conduct of our railroads.

Looking into the future, it is reasonable to predict that terminal development will undergo greater relative development than any other phase of transportation. It is of the utmost importance to mechanical officers that they not only have the foresight to realize the extent to which terminal equipment must be rehabilitated and the organization strengthened but the courage to command a program that will make the locomotive terminal a successful operating factor.

Boards of Adjustment to Be Abolished

John Barton Payne, director general of railroads, has issued a circular announcing the abolition of the boards of adjustment created by the Railroad Administration as follows:

"A committee representing the Association of Railroad Executives has brought to my attention the fact that General Orders 13, 29 and 53 provide in terms that,

> 'Personal grievances and controversies arising under interpretation of wage agreements and all other disputes arising between officials of a railroad and its employees covered by this understanding will be handled in their usual manner by joint committees of the employees up to and including the chief operating officer of the railroad (or some one officially designated by him). If an agreement is not reached, the chairman of the joint committee of employees refers the matter to the chief executive officer of the organization concerned. If the contention of the employees' committee is approved by such executive officer, then the chief operating officer of the railroad and the chief executive officer of the organization concerned shall refer the matter with all supporting papers to the director of the Division of Labor of the U. S. Railroad Administration, who will in turn present the case to the Railway Board of Adjustment, which board would promptly hear and decide the case, giving due notice to the chief operating officer of the railroad interested and to the chief executive officer of the organization concerned of the time set for the hearing.'

"That after the order of May 29, 1920, and amendment under which the time limit of July 15 was fixed within which claims growing out of the subject matter of said orders should be presented the claimants, without complying with the procedure specified in said general orders, presented their claims direct to the office of the director general and, in view of this fact, none of the said claims are now properly before said adjustment boards.

"I have given careful consideration to each contention and am advised that if said contention is sustained, practically all of the cases now pending before Boards of Adjustment 1, 2 and 3 will fall and must fail of consideration.

"The point made by the representatives of the executives appears to me to be sound and there is nothing contained in the limitation order of May 29, 1920, changing the mode of procedure. But as I look upon the matter the railroads as such are not concerned in the pending claims, if the claims are limited, as in my judgment they must be limited, to the period of federal control. That is, it is for the director general to determine and to pass upon claims against the government by persons who were the employees of the government during the period of federal control and to provide for the payment of all just claims arising during federal control, just as he must pass upon and provide for the payment of all other claims arising from federal control.

"If, however, the decision of these claims is to affect the railroads after the end of federal control, then the railroads have the right to insist upon a strict compliance with the terms of the said general orders.

"I am further advised that Board No. 1 will be able to dispose of all leases pending before it by February 15, that the number of cases pending before Boards 2 and 3 are so large that many months must elapse before said Boards could dispose of them.

"My conclusion, therefore, is that as to cases pending before Boards 2 and 3 some other means must be found to deal justly by the claimants as to any money due them arising out of federal control.

"The application of all decisions hereafter made to be limited in their effect to money due claimants between January 1, 1918, and March 1, 1920.

"It is, therefore, ordered that Board No. 1 be abolished as of February 15, 1921; that Board No. 2 and Board No. 3 be abolished as of January 10, 1921; i. e., by 30 days' notice, as provided in said General Orders.

"Meantime, means will be provided to adequately, justly and promptly dispose of all claims which said boards may leave undisposed of."

The views of railroad officials and representatives of organized railroad employees are widely at variance as to the desirability of establishing national boards.

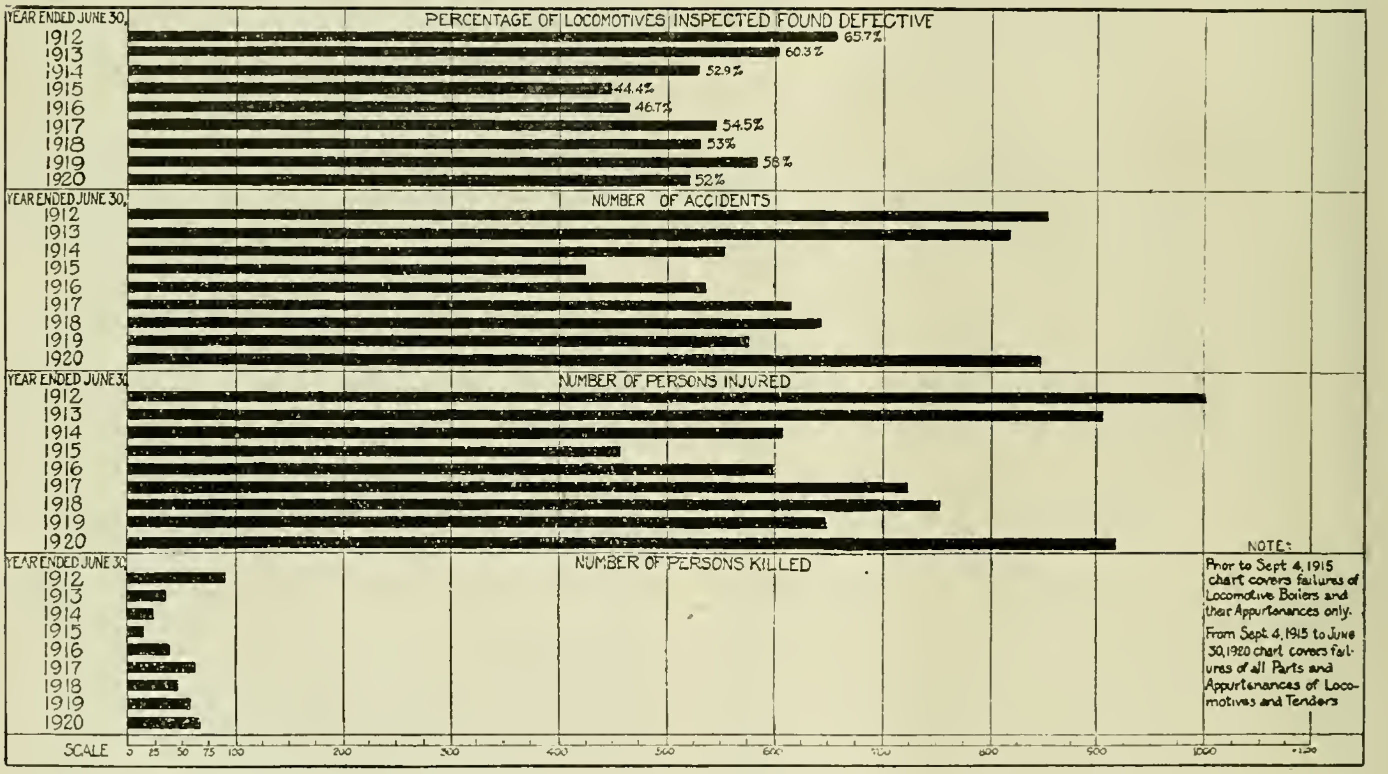
The directors of the Chamber of Commerce of the United States recently adopted a resolution opposing the creation of national boards of adjustment as not in the public interest. The preamble states that the public interest is involved in that no provision is made for public representation on the proposed boards. The resolution goes on to state that the establishment of the boards would tend to bring about a state of nationalization of the railroads, that they would lessen efficiency and impair the discipline necessary to successful operation of the railways. Furthermore, they would prevent open shop operation on the railroads and this would inevitably be extended to other industries.

Report of the Bureau of Locomotive Inspection

Application of Water Columns and Other Devices Advocated; Accidents Increase in Fiscal Year 1920

THE outstanding feature of the report of the chief inspector of locomotive boilers to the Interstate Commerce Commission for the fiscal year ending June 30, 1920, is the increase in the number of accidents and casualties resulting from failures of parts of locomotives and tenders. Although the percentage of locomotives inspected which were found defective decreased from 58 per cent in 1919 to 52 per cent in 1920, the number of accidents increased 49 per cent, the number killed 15 per cent and the number injured 41 per cent. A summary of the chief inspector's report is given below.

The succeeding tables and charts have been arranged so as to permit comparison with previous reports, as far as consistent, and show in concrete form the number of locomotives inspected, the number and percentage of those inspected found defective, and the number ordered out of service because of not meeting the requirements of the law, together with the total number of defects found. They also show the total number of accidents caused by failure from any cause of the locomotive or tender, including the boiler, and all parts and appurtenances thereof, reported by the carriers, or discovered by inspectors, together with the number of persons killed or injured due to such failure.



Graphic Summary of Results of Inspection and Accidents Due to Locomotive Failures, 1912-1920

LOCOMOTIVES INSPECTED, NUMBER FOUNO DEFECTIVE, PERCENTAGE INSPECTED FOUND DEFECTIVE, NUMBER ORDERED OUT OF SERVICE, AND TOTAL DEFECTS FOUND BY COMPARISON

	1920	1919	1918	1917
Number of locomotives inspected....	49,471	59,772	41,611	47,542
Number found defective............	25,529	34,557	22,196	25,909
Percentage found defective.........	52	58	53	54.5
Number ordered from service.......	3,774	4,433	2,125	3,294
Total defects found................	95,066	135,300	78,277	84,883

NUMBER OF ACCIDENTS, NUMBER KILLED, AND NUMBEB INJUBED, REPORTED, AND INVESTIGATED, COVERING FAILURES OF ALL PARTS AND APPURTENANCES OF THE ENTIRE LOCOMOTIVE AND TENDER BY COMPARISON

	1920	1919	1918	1917
Number of accidents................	843	565	641	616
Decrease from previous year.......	[1]49.2	[1]11.8	[1]4.1	....
Number killed	66	57	46	62
Decrease from previous year......	[1]15.8	[1]23.9	25.8	....
Number injured	916	647	756	721
Decrease from previous year.......	[1]41.6	14.4	[1]4.8	....

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[1] Increase.

The following table shows the number of accidents, number of persons killed, and number injured, due to the failure of some part or appurtenance of the locomotive boiler only, which were reported by the carriers, with their percentage of decreases by comparison of the fiscal years ended June 30, 1912 and 1913, with the fiscal years ended June 30, 1919 and 1920:

	1920	1919	1913	1912
Number of accidents..............	439	341	820	856
Increase 1920 over 1919.........	28.8	....	....	....
Decrease 1920 from 1912.........	48.7	....	....	....
Number killed.....................	48	45	36	91
Increase 1920 over 1919.........	6.7	....	....	....
Decrease 1920 from 1912.........	47.2	....	....	....
Number injured	503	413	911	1,005
Increase 1920 over 1919.........	21.8	....	....	....
Decrease 1920 from 1912.........	49.9	....	....	....

NUMBER OF DERAILMENTS DUE TO DEFECTS IN OR FAILURE OF PARTS OF THE LOCOMOTIVE OR TENDER, REPORTED TO AND INVESTIGATED BY THIS BUREAU, AND NUMBER OF PERSONS KILLED AND INJURED AS A RESULT, BY COMPARISON

	1920	1919	1918	1917
Number of derailments[1]................	7	7	2	4
Number killed	7	6	..	1
Number injured........................	18	7	2	21

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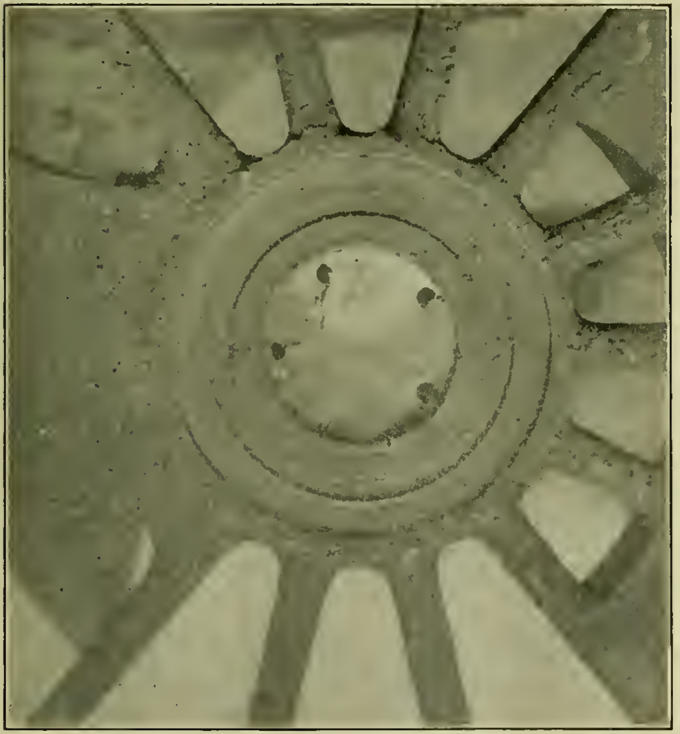
[1] Only derailments, reported as being caused by defects in or failure of parts of the locomotive or tender bave been investigated by tbis bureau.

The following table shows the total number of persons killed and injured by failure of locomotives or tenders, or some part or appurtenance thereof, during the four years ended June 30, 1917-1920, classified according to occupations.

	1920		1919		1918		1917	
	Killed	Injured	Killed	Injured	Killed	Injured	Killed	Injured
Members of the train crew:								
Engineers	16	272	14	194	11	245	16	230
Firemen	20	404	22	265	19	306	21	304
Brakemen	9	77	11	82	6	62	13	60
Conductors	2	19	2	16	..	21	3	14
Switchmen	4	19	1	7	2	..	..	8
Roundhouse and shop employees:								
Boiler makers	2	9	1	9	..	11	..	11
Machinists	1	20	..	5	..	11	..	8
Foremen	..	3	..	3	1	4	..	1
Inspectors	..	1	..	6	4	4	..	3
Watchmen	4	3	..	2	..	3	..	5
Boiler washers	..	13	..	7	1	4	..	7
Hostlers	..	13	..	6	..	8	..	6
Other roundhouse and shop employees	3	30	1	11	2	19	2	19
Other employees	4	26	3	23	..	26	5	22
Nonemployees	1	7	2	11	..	24	1	23
Total	66	916	57	647	45	756	62	721

A summary of all accidents and casualties occurring during the fiscal year ended June 30, 1920, as compared with the year ended June 30, 1919, covering the entire locomotive and tender and all of their parts and appurtenances, shows an increase of 49 per cent in the number of accidents, an increase of 16 per cent in the number killed, and an increase of 42 per cent in the number injured. This increase is due almost wholly to disregard for the requirements of the law and rules as well as to safety of construction and operation. This is especially true with what are sometimes considered unimportant parts; for instance, 26 per cent of the increase in accidents and injuries was due to failure of grate shakers; 10 per cent was due to failure of reversing gear; and 10 per cent to failure of squirt hose.



Failure of Driving Axle Caused by Fracture Starting at Bottom of Holes Drilled for Plugs Used in Attempt to Tighten Wheel Fit

A summary of all accidents and casualties caused by failure of the boiler and its appurtenances only, for the fiscal year ended June 30, 1912 (the first year of the existence of the law), as compared with the year ended June 30, 1920, shows a decrease of 47 per cent in the number of accidents, a decrease of 48 per cent in the number killed, and a decrease of 49 per cent in the number injured. These decreases are especially gratifying when considering the increased number of locomotives in service and the increased traffic being handled, together with the increased duties imposed on the inspectors by the amendment to the boiler-inspection law, which extended their duties to the entire locomotive and tender and the parts and appurtenances thereof, which has added greatly to their work. These decreases demonstrate the wisdom of complying with the requirements of the law and rules, and the wisdom and foresight of its advocates when requesting its enactment.

As shown by the table, derailments due to defects in or failure of parts of the locomotive or tender have been the direct cause of a number of most serious accidents and the loss of life and limb as well as damaged property and have forcibly demonstrated the necessity for proper inspection and repair of the running gear, driving gear, and brake rigging.

Corroded Main Air Reservoir Which Exploded, Causing the Death of One Person

During the year the inspectors of this bureau were called upon by the commission to perform various duties not in connection with their regular work, which materially reduced the number of locomotives shown inspected by them, as well as the number ordered out of service, and it appears that certain railroad officials and employees have taken advantage of their temporary absence and permitted locomotives to remain in service with serious defects, which would have been known to them had proper inspections been made and reports rendered as required.

It was found necessary to ask the courts to inflict the penalty provided in section 9 of the law, because of the defective condition in which locomotives were being operated by one carrier and its willful violation of the requirements of the law and rules. This case is now pending and is set for the October term of the court. It is evident that unless an immediate improvement is made by certain other carriers it will be necessary to file similar suits in the near future. That the law places the burden of proper inspection and repair and compliance with the rules of inspection on the carriers owning or operating the locomotives seems to have been lost sight of, and this is reflected in the increased number of accidents and casualties during the year.

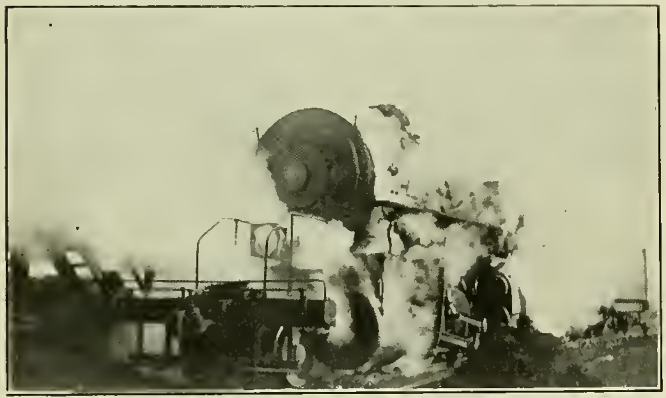
Referring to failures of seams in boilers welded by the autogenous process, the recommendation made in the last annual report that such methods should not be applied to any part of the boiler where the strain is not carried by other construction nor in the low water zone of the firebox, is repeated, with the further recommendation that this should apply to all parts of the locomotive and tender subject to severe stresses and shocks where failures might cause accidents. During the year, 258 applications were filed for extension of time for the removal of flues, as provided in rule 10. Investigation showed that in 31 of these cases, the condition of the locomotives was such that no extension could properly be granted. Twenty-five were in such condition that the full extension requested could not be granted, but an extension for a shorter period within the limits of safety was allowed. Ten extensions were granted after defects disclosed by our investigation had been repaired. Thirty-seven applications were withdrawn for various reasons and the remaining 155 were granted for the full period requested.

During the year, close attention was given to the equipping of locomotives with headlights that would meet the requirements of the commission's orders of December 26, 1916, and December 17, 1917, and reports indicate that on July 1 practically all locomotives in service were equipped in accordance therewith.

No formal appeal has been taken from the decision of any inspector, during the fiscal year.

A large part of the report is devoted to an account of the tests of water indicating devices conducted by the bureau which were described in the *Railway Mechanical Engineer* for September and October, 1920, pages 575 and 630.

The chief inspector calls attention to the fact that services of the inspectors were required in making various investigations during the year and, in view of this fact, recommends that the act of February 17, 1911, be amended so as to provide for additional inspectors, to be appointed by the commission, upon the recommendation of the chief inspector, as the needs of the service develop. Other recommendations that are repeated are as follows:



A Locomotive That Is Not Only Unsafe But Also Uneconomical

That all locomotives not using oil for fuel have a mechanically operated fire door, so constructed that it may be operated by pressure of the foot on a pedal or other suitable device.

That all locomotives be provided with a bell so arranged and maintained that it may be operated from the engineer's cab by hand and by power.

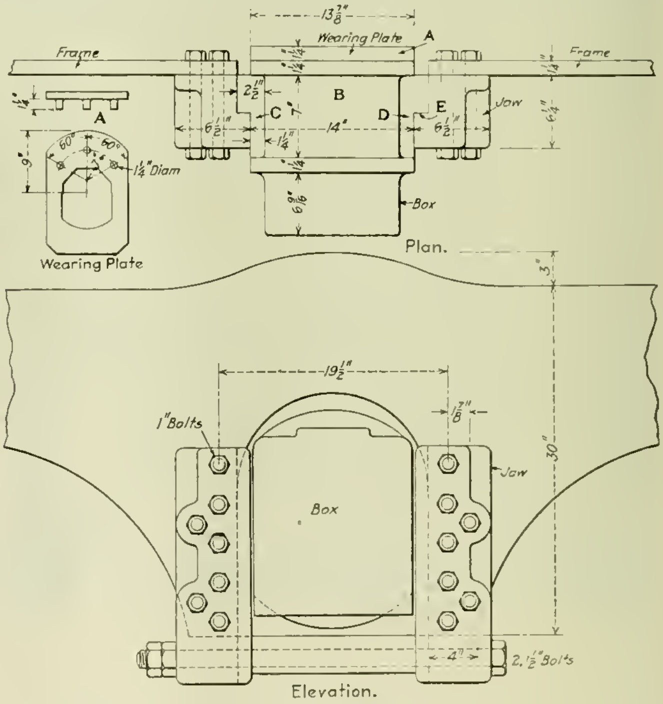
That cabs of all locomotives not equipped with front doors or windows of such size as to permit of easy exit, have a suitable stirrup or other step, and a horizontal handhold on each side, approximately the full length of the cab, which will enable the enginemen to go from the cab to the running board in front of it; handholds and steps or stirrups to be securely fastened with bolts or rivets; the distance between the step and handhold to be not less than 60 inches nor more than 72 inches.

That all locomotives where there is a different indication between the gage cock and water glass of two or more inches of the water level under any conditions of service be equipped with a suitable water column to which shall be attached three gage cocks and one water glass with not less than 6 in., preferably 8 in., clear reading, and one additional water glass with not less than 6 in., preferably 8 in., clear reading, located on the left side or back head of the boiler. The water glasses to be so located, constructed, and maintained that they will register the approximate general water level in the boiler under all conditions of service and show a corresponding level within 1 inch and be so located, constructed, and maintained that the engineer and fireman may under all conditions of service have an easy and clear view of the water in the glass from their respective and proper positions in the cab. The gage cocks to be so located that they will be in easy reach of the engineer from his proper position in the cab.

The usual chart showing the number of accidents occurring during the fiscal year from 1912 to 1920 due to failure of various parts of a locomotive, is shown, and this information is also given in tabular form. Another section of the report lists the accidents occurring on each railroad under the jurisdiction of the bureau, with a summary in tables which show also the number of locomotives inspected and the numbers found defective and ordered from service. A supplement at the conclusion of the report shows typical examples of defective conditions and accidents resulting from defects with a short account of the causes of the failure.

Trailer Box With Lateral Adjustment

The Ann Arbor railroad has equipped its Atlantic type locomotives with a trailer box and pedestal that permits the application of the lateral plate without dropping the wheels and also makes possible the taking up of lateral play until the plate is entirely worn out. The arrangement is illustrated in elevation and plan in the drawing shown herewith.



A Unique Type of Trailer Box Pedestal Designed to Facilitate Repairs

In this design, the jaws are set far enough apart to permit the withdrawal of the box *B* as keys *C* and *D* are raised vertically out of place. This permits the application of a wearing plate *A* after which the box is replaced in position and the keys *C* and *D* dropped into their places. In order to use up the wearing plate completely and at the same time keep the lateral motion within the prescribed limits, keys of bar iron may be inserted at the shoulder marked *E*. After the plate is completely worn out by the application of these filling blocks, a new wearing plate may be applied. This arrangement, which was originated by J. E. Osmer, superintendent of motive power of the Ann Arbor, has been very successful in service.

Federated American Engineering Societies' Meeting

Herbert Hoover Speaks on Some Phases of Relationship of Engineering Societies to Public Service

THE first meeting of the Federated American Engineering Societies as an independent organization was held at the New Willard Hotel, Washington, D. C., on November 18, 19 and 20. Herbert Hoover was unanimously elected president of the American Engineering Council, and thus becomes the active head of this organization. Twenty-one member societies and nine societies which have not yet taken final action, participated in the meeting.

The executive board of thirty members was elected in part. As there were a number of societies which were expected to join shortly, four vacancies were left on the board in order that these societies might later be given proper representation. According to the societies' constitution, the country was divided into six districts as follows:

District 1—New England and New York.
District 2—Michigan, Wisconsin and Minnesota.
District 3—Ohio, Indiana and Illinois.
District 4—New Jersey, Pennsylvania, Delaware, Maryland and the District of Columbia.
District 5—All the southern states, including Louisiana and Texas, and
District 6—All other states west of the Mississippi river.

Of the national societies, the American Society of Mechanical Engineers received 4 places; the American Institute of Mining and Metallurgical Engineers, 3; the American Institute of Electrical Engineers, 4; the American Institute of Chemical Engineers, 1; the American Society of Agricultural Engineers, 1; and the Society of Industrial Engineers, 1. The executive officers elected are Herbert Hoover, Palo Alto, Cal., president; Calvert Townley, New York, vice-president; W. E. Rolfe, St. Louis, Mo., vice-president; D. S. Kimball, Ithaca, N. Y., vice-president; J. Parke Channing, New York, vice-president; and L. W. Wallace, Baltimore, Md., treasurer. Members of the executive board were elected to represent the organizations mentioned above and also some of the local districts.

No permanent location for headquarters was chosen, although the majority felt that in order to carry on the work of public service for which the federation was organized, it would be necessary to maintain an office in Washington. It was decided that the headquarters be located in that city after January 1, 1921, and until that time the society would carry on its work in the Washington office of the Engineering Council through the courtesy of that organization.

The Committee on Plan and Scope presented a large number of topics of interest to the public at large which would give the society an opportunity for constructive work. The more important of these included the conservation of labor or the reduction of economic waste, transportation, the establishment of a department of public works, national fire protection, patents, licensing of engineers, education, compensation, service bureau and numerous others, some of which are now in the hands of the Engineering Council.

Of the public service work to be undertaken, the reduction of economic waste will probably receive first consideration. Mr. Hoover emphasized this strongly in an address on "Some Phases of Relationship of Engineering Societies to Public Service." An abstract of the address follows:

Address of Herbert Hoover

The greatest of the problems now before the country and, in fact, before the world, are those growing out of our industrial development. The enormous industrial expansion of the last 50 years has lifted the standard of living and comfort beyond any dream of our forefathers.

We have built up our civilization, both political, social and economic, on the foundation of individualism. We have found in the course of development of large industry upon this system that individual initiative can be destroyed by allowing the concentration of industry and service, and thus an economic domination of groups over the whole. While our present system of individualism under controlled capitalism may not be perfect, the alternative offers nothing that warrants its abandonment. Our thought, therefore, needs to be directed to the improvement of this structure and not to its destruction.

A profound development of our economic system apart from control of capital and service during the last score of years has been the great growth and consolidation of voluntary local and national associations. These associations represent great economic groups of common purpose, and are quite apart from the great voluntary groups created solely for public service. This engineers' association stands somewhat apart among these economic groups in that it has no special economic interest for its members. Its only interest in the creation of a great national association is public service, to give voice to the thought of the engineers in these questions. And if the engineers, with their training in quantitative thought, with their intimate experience in industrial life, can be of service in bringing about co-operation between these great economic groups of special interests, they will have performed an extraordinary service.

Relations Between Employer and Employee

We have just passed through a period of unparalleled speculation, extravagance and waste. We shall now not only reap its inevitable harvest of unemployment and readjustment, but we shall feel the real effect of four years of world destruction, and from it economic and social problems will stand out in vivid disputation. One of the greatest conflicts rumbling up in the distance is that between the employer on one side and organized labor on the other. There are certain areas of conflict of interest, but there is between these groups a far greater area of common interest, and if we can find measures by which, through co-operation, the field of common interest could be organized, then the area of conflict could be in the largest degree eliminated.

The American Federation of Labor has publicly stated that it desires the support of the engineering skill of the United States in the development of methods for increasing production, and I believe it is the duty of our body to undertake a constructive consideration of these problems and to give assistance not only to the Federation of Labor but also to the other great economic organizations interested in this problem, such as the Employers' Association and the chambers of commerce.

The Three Great Wastes in Production

It is primary to mention the three great wastes in production; first, from intermittent employment; second, from unemployment that arises in shifting of industrial currents, and third from strikes and lockouts. Beyond this elimination of waste there is another field of progress in the adoption of measures for positive increase in production.

In the elimination of the great waste and misery in intermittent employment and unemployment, we need at once co-ordination in economic groups. For example, in the bituminous coal industry where the bad economic functioning of that industry results in an average of but 180 days' employment per annum, a great measure of solution could be had if a basis of co-operation could be found between the coal operators, the coal miners, the railways and the great consumers. The combined result would be a higher standard of living to the employees, a reduced risk to the operator, a fundamental expansion of economic life by cheaper fuel. With our necessary legislation against combination and the lack of any organizing force to bring about this co-operation, the industry is helpless unless we can develop some method of governmental interest, not in governmental ownership, but in stimulation of co-operation in better organization. In the great field of seasonal and other unemployment, we indeed need an expansion and better organization of our local and federal labor exchanges. The individual worker is helpless to find the contacts necessary to make this seasonal shift unless the machinery for this purpose is provided for him.

In the questions of industrial conflict resulting in lockouts and strikes, one mitigating measure has been agreed upon in principle by all sections of the community. This is collective bargaining, by which, whenever possible, the parties should settle their difficulties before they start a fight. The point where the universal application of collective bargaining has broken down is in the method of its execution. The conflict arises almost wholly over the question of representation and questions of enforcement. The second Industrial Conference proposed a solution to this point by the provision that where there was a conflict over representation the determination should be left to a third and independent party. It also proposed that each party should have the right to summon skill and experience to its assistance. It further proposed that where one of the parties at dispute refuses to enter upon collective bargaining, the entire question should be referred to an independent tribunal for investigation as to the right and wrong of the whole dispute—but only for investigation and report.

Hours of Labor

There are questions in connection with this entire problem of employer and employee relationship, both in its aspects of increased production and in its aspects of wasteful unemployment, that deserve most careful study by our engineers. There lies at the heart of all these questions the great human conception that this is a community working for the benefit of its human members, not for the benefit of its machines or to aggrandize individuals; that if we would build up character and abilities and standard of living in our people, we must have regard to their leisure for citizenship, for recreation and for family life. These considerations, together with protection against strain, must be the fundamentals of determinations of hours of labor. These factors being first protected, the maximum production of the country should become the dominating purpose.

The precise hours of labor should and will vary with the varying conditions of trades and establishments, but the proper determination of hours, based upon these factors, is an immediate field demanding attention of engineers. There is no greater economic fallacy than the doctrine that the decrease of hours below these primary considerations makes for employment of great numbers, and it is an equal certainty that the 84-hour week of some employments transgresses these fundamentals to a point of inhumanity.

Incentive and Increased Production

There is a broad question bearing upon stimulation of self-interest and thus increase in production that revolves around the method of wage payment. I need not review to you the advantages, difficulties and weaknesses of bonus, piece work, profit or saving sharing plans that are in use as a remedy for the deadening results of the same wage payment to good and bad skill alike. A suggestion for your consideration is the possible use of another device in encouragement of individual interest and effort by creating two or three levels of wage in agreements for each trade, the position of each man in such scale to be based upon comparative skill and character. This plan should be developed upon the principle of graded extra compensation, for added skill and performance, above an agreed basic wage. In order to give confidence, the classification under such scales must be passed upon by representatives of the workers in such shop or department. This plan is now being successfully experimented with.

We must take account of the tendencies of our present repetitive industries to eliminate the creative instinct in its workers, to narrow their field of craftmanship, and to discard entirely the contribution to industry that could be had from their minds as well as from their hands. There has been a great increase in shop committees as a method to relieve this tendency. Where they have been elected by free and secret ballot among the workers, where they are dominated by a genuine desire on both sides for mutual co-operation in the shop, they have resulted in great good. Organized labor has opposed some forms of these committees because of the fear that they may break down trade organization covering the area of many different shops.

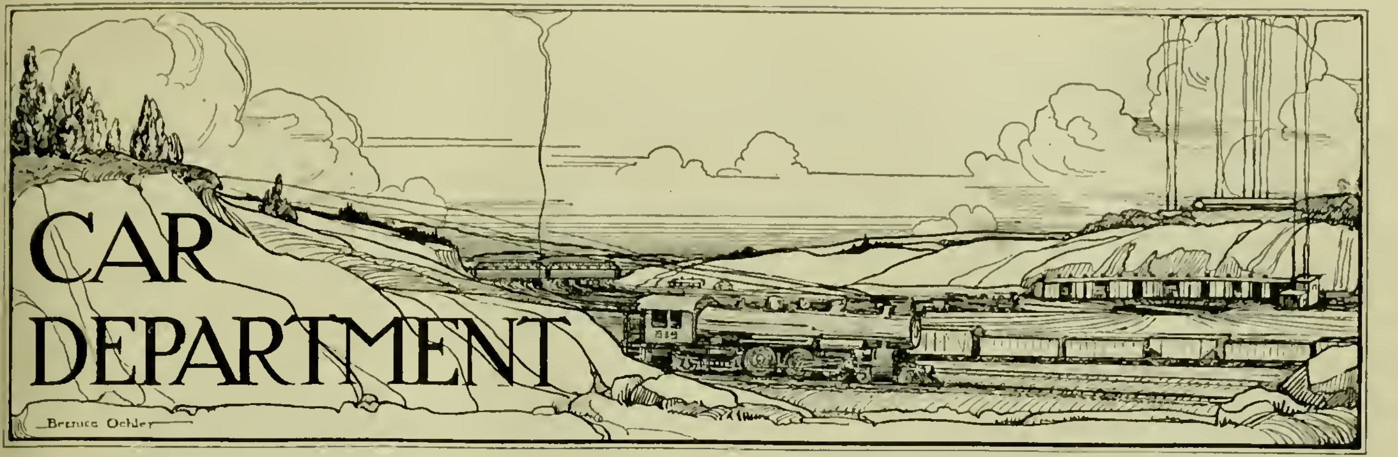
Co-operation with Labor Organizations

Again I believe the engineers could assist in the erection of a bridge of co-operation if organized labor, which has already made a beginning, would extend more widely its adoption of the principles of a shop committee settling its problems of wage and conditions of labor in general agreement and applying its energies through shop committee organization to development of production as well as to the correction of incidental grievance. There would be little outcry against the closed shop if it were closed in order to secure unity of purpose in constructive increase of production by offering to the employer the full value of the worker's mind and effort as well as his hands.

While it is easy to state that increased production will decrease cost and by providing a greater demand for goods secure increased consumption and ultimate greater employment, yet the early stages of this process do result in unemployment and great misery. It takes a variable period of time to create the increased area of consumption of cheapened commodities, and in the meantime, when this is translated to the individual worker he sees his particular mate thrown out of employment. We accomplish these results over long periods of time, but if we would secure co-operation to accomplish them rapidly we must take account of this unemployment and we must say to the community that if it is to benefit by the cheapening costs and thus the increased standard of living, or alternatively if the employer is to take the benefits, the entire burden should not be thrust upon the individual who now alone suffers from industrial changes. Nor can this be accomplished except by co-operation between groups.

I am not one of these who anticipates the solution of these things in a day. Durable human progress has not been founded on long strides. But in your position as a party of the third part to many of these conflicting economic groups, with your lifelong training in quantitative thought, with your sole mental aspect of construction, you, the engineers, should be able to make contribution of those safe steps that make for real progress.

Coal Output Per Miner.—The average production for each underground worker employed in the coal mines of the United States during 1918 was 1,134 short tons, according to statistics published by the United States Bureau of Mines. Our closest competitor is New South Wales, where each underground worker in 1918 produced 814 tons. The smallest individual output of recent years was that of Japan in 1917, with an average of 155 tons.



CAR DEPARTMENT

Ball Bearings for Railway Cars

During recent years ball bearings have been developed for use under very heavy loads and have been successfully applied under difficult conditions. The allowable pressure on ball bearings decreases as the speed increases and the adaptation of ball bearings to the high speeds and heavy loads met in passenger cars is therefore a difficult problem. One of the latest developments is the application of a modified type of ball bearings in the trucks of passenger cars. This form of bearing is in service in Sweden and its use in this country is now being considered.

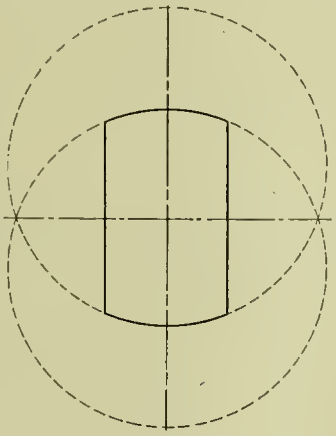


Fig. 1

The use of ball bearings in railroad equipment was discussed in a recent paper before the Swedish Technological Society of Stockholm. The author of the paper, A. Danielson, pointed out that the advantages of ball bearings are due to the smaller loss of energy through friction, the lessening of danger of overheating, greater ease of handling, smaller consumption of oil and less attendance required. Where heavy loads are carried, roller bearings have come into competition with ball bearings, but the author pointed out that the coefficient of friction was higher and the saving of energy with the common types of roller bearings, compared with plain bearings, is often very small. Moreover, the application of most roller bearings is limited, due to the fact that very few types can take any end thrust.

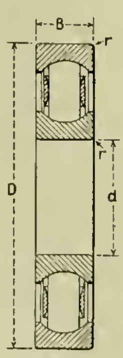


Fig. 2

Experiments conducted by Stribeck showed the coefficient of friction in roller bearings with spiral rolls was about 0.4 per cent and in a bearing with long cylindrical steel rollers between 0.7 and 1.4 per cent. The coefficient of friction in a ball bearing is 0.1 to 0.15 per cent. The increased friction of the roller bearing is due to the fact that the rollers tend to go crosswise, thus setting up a sliding motion. It is therefore desirable that the rollers in a roller bearing should be self-alined and, with this in mind, the so-called disk bearing manufactured by the Nordiska Kulluager Aktiebolaget (Northern Ball Bearing Company), Gothenburg, Sweden, was designed. It has been found that rollers of the form shown in Fig. 1 when moving between two planes have a peculiar rolling motion. Provided the upper plane can rise and fall, the horizontal axis will assume a normal position at right angles to the direction of motion. This also holds true when the disks move between round and not between plane surfaces, as in the disk bearing. By the form of roller shown, the strength of the roller bearing is combined with the easy running of the ball bearing, the effective capacity of the disc being the same as for a ball of the diameter shown by the dotted lines.

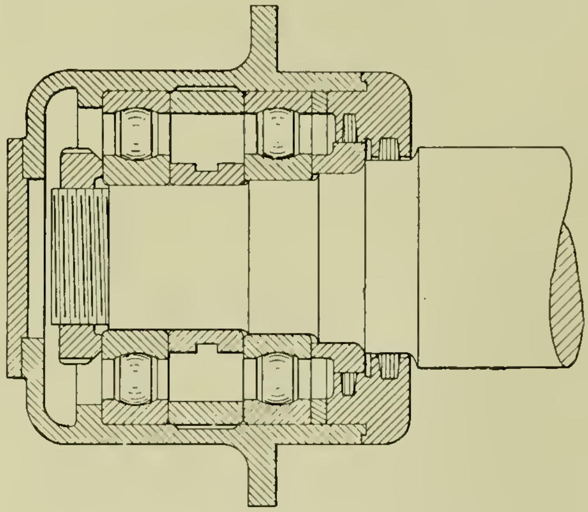


Fig. 3—Journal Box With Disc Bearings Used On the Swedish State Railways

The arrangement of the rollers or disks, as they are called, with the races and cage, is shown in Fig. 2. The race rings have concave grooves which conform fairly closely to the outline of the disks. As any axial displacement of the outer ring tends to compress the roller, such a bearing is able to carry a thrust load. Due to the self-alining feature, the disks adjust themselves at an angle so that the resultant pressure is normal to the axis of the disk. If the axial stress arises suddenly, the disk does not immediately adjust itself, but takes the stress nevertheless. The cage for disk bearings is so formed that the disks can adjust themselves under the influences of axial pressure.

The load capacity of the disk bearing is stated to be about 60 per cent greater than for ball bearings of corresponding dimensions. The coefficient of friction is about 0.13 per cent, or about the same as for ball bearings. The design of disk bearing box used on the Swedish railways is shown in Fig. 3. On each journal are placed two bearings of the same type and dimensions which are coupled together so that they take up axial pressure in common.

In the absence of test data to show the saving effected by the reduction of friction, Mr. Danielson submitted calculations on a theoretical basis. The average resistance of the car with journal bearings was assumed to be as shown in Fig. 4, these curves being the results of tests of cars with plain and ball bearings conducted on the Swedish state railways. From these experiments modified on a basis of Stribeck's investigations of journal friction, the resistance curves for trains with disk bearings and with journal bearings have been derived as shown in Fig. 5. On the basis of a train consisting of an engine weighing 70 long tons with the weight of the tender and cars equal to 400 tons, operating over a given section of road, 200 kilometers long, the coal consumption was assumed to be 0.323 kilograms per car axle kilometer (1.15 lb. per car axle mile) and the price of coal was taken at 155 kroner ($31.00) per ton.* Assuming an annual traffic of 140,000 car-axle kilometers, the saving amounted to 983 kroner (about $196.60) per car. On this basis, the saving would pay the cost of the new bearings in about a year and a half, including the expense of periodical overhauling.

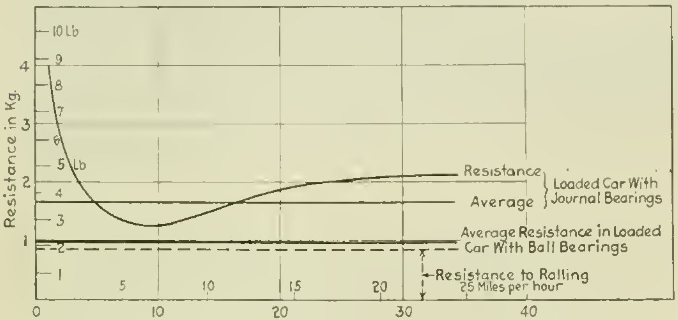


Fig. 4—Rolling and Total Resistance of Cars With Ball Bearings and Journal Bearings

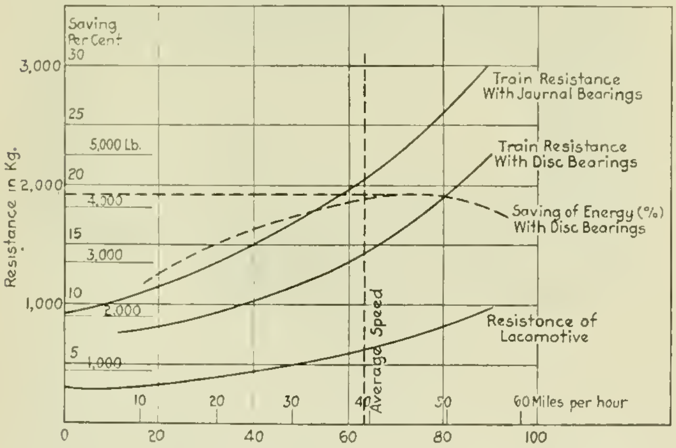


Fig. 5—Train Resistance With Journal Bearings and Disc Bearings and Saving of Energy

In freight service, the percentage of coal saved would not be so great as the distance traveled in a year by each car would be less, but since the life of the bearings is likely to be greater, it is believed that even on freight cars disk bearings would prove economical. With freight cars the advantage of easier starting would assume greater importance. In ore traffic on the Swedish State Railways it has been established that the same engine with equal coal consumption is able to haul 28 or 33 cars provided with sliding bearings and ball bearings, respectively, on the line between Kiruna and Gellivare, equal to a coal saving of 18 per cent. On the line from Ripats to Lulea the corresponding numbers are 29 and 38 ore cars, equal to a coal saving of 31 per cent. On an electric road a four-axle car equipped with ball bearings has shown a saving of energy, measured in electric units, of 23 per cent.

The first car to which the disk bearings were applied weighs 36 tons, including the weight of passengers, which makes the pressure on each journal 4.5 tons. The car had covered 190,000 kilometers (118,000 miles) in fast passenger service on Nov. 9, 1920, and the original set of bearings was still in use.

The Swedish State railways have also had ball bearings in service since 1913 on cars weighing 42 and 43 tons, an average journal pressure of 5.2 tons. The first defect developed after the car had traveled 240,000 kilometers (149,000 miles). One car has been in service for two years without any defects in the bearings. Other companies are developing entirely new types of ball bearings and further improvements are anticipated.

Periodical Repairs for Freight Cars*

BY F. S. GALLAGHER

Engineer of Rolling Stock, New York Central

A freight car is constructed and the manufacturers are instructed to deliver it to some point where it is put in service and there it stays until it is about ready to drop to pieces. In the case of locomotive or passenger car it is different. Locomotives are usually brought into the shop and given designated repairs after certain mileage, and the same is true with the coach, but it is usually based on a time period. But the freight car, the most important of all vehicles, is put into service and given no attention whatever except the attention necessary to keep it in running condition and maintain safety appliances. Why should we not treat a freight car in the same manner as we do a passenger car or locomotive, by bringing it into the shop after a certain designated mileage, or after a certain length of service, and make certain repairs, thus always keeping the car in first-class condition?

This is a scheme which would take some study to work out properly, but when once worked out I believe would work to the advantage of the railroad company, because at all times we would know the condition of the equipment. To successfully work out a scheme of this kind would require the co-operation of all of the railroads in the country. If cars were stenciled in a manner to indicate during what period they should receive their periodical repairs, the railroad in whose possession the cars might be would be responsible to the owning road to see that the repairs are made or the cars are returned home for repairs. This would necessitate making it a requirement in interchange that the cars be either repaired or sent to the home road for repairs.

This periodical repair might not amount to much, it might possibly be painting or proper attention to the draft gear, or repairs to some of the brake apparatus. but it seems to me that there should be some designated time when a freight car should be brought into the shops for necessary repairs other than depending upon the judgment of the yard inspector as to whether or not the car should continue. I think we would have a large decrease in so-called heavy repairs and rebuilding if we could periodically bring the cars in and do certain things to them.

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*The normal value of the kroner is about 26 cents and the present value about 20 cents.

*From a paper presented before the New York Railroad Club.

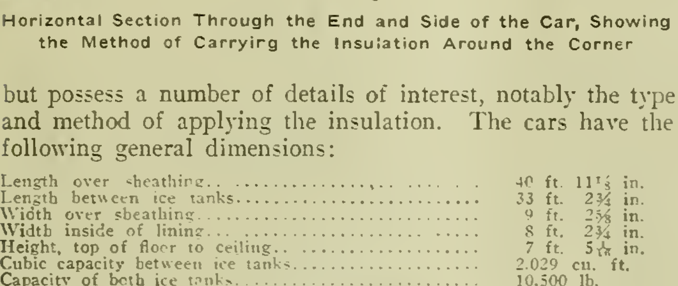
Pacific Fruit Express Refrigerator Cars

Insulation Around the Sides and Ends is Unbroken: A Continuous Layer of Cork in the Floor

THE Union Pacific has recently placed in service 4,000 refrigerator cars for the Pacific Fruit Express, 1,000 of which were built in the company's shops and orders for 3,000 of which were distributed among the following builders:

Pullman Company	900
American Car & Foundry Company	900
Haskell & Barker Car Company, Inc	700
Mt. Vernon Car Manufacturing Company	300
Pacific Car & Foundry Company	200

These cars in general follow conventional lines of design but possess a number of details of interest, notably the type and method of applying the insulation. The cars have the following general dimensions:



Horizontal Section Through the End and Side of the Car, Showing the Method of Carrying the Insulation Around the Corner

Length over sheathing	40 ft. 11⅛ in.
Length between ice tanks	33 ft. 2¾ in.
Width over sheathing	9 ft. 2⅝ in.
Width inside of lining	8 ft. 2¾ in.
Height, top of floor to ceiling	7 ft. 5 1/16 in.
Cubic capacity between ice tanks	2.029 cu. ft.
Capacity of both ice tanks	10,500 lb.
Distance from center to center of body bolsters	30 ft. 8 in.
Truck wheel base	5 ft. 6 in.
Capacity	60,000 lb.
Truck capacity	80,000 lb.
Light weight of car complete (built up centre sill)	53.500 lb.
Light weight of car complete (Bettendorf)	52,200 lb.

The cars were built to two designs, differing only in the trucks and underframe construction. In one of these the Bettendorf single I section center sill and Bettendorf trucks are used while the other involves a double fish belly center sill built up of plates and structural sections, and is carried on Vulcan trucks.

Underframes

The principal member of the Bettendorf underframe is an 18-in., 92-lb. Bethlehem girder, the depth of which is reduced to 14 in. at the bolster. The bolster is an 8-in., 34.5-lb. H-section, which is framed through the center sill and the rear ends of the draft sill castings.

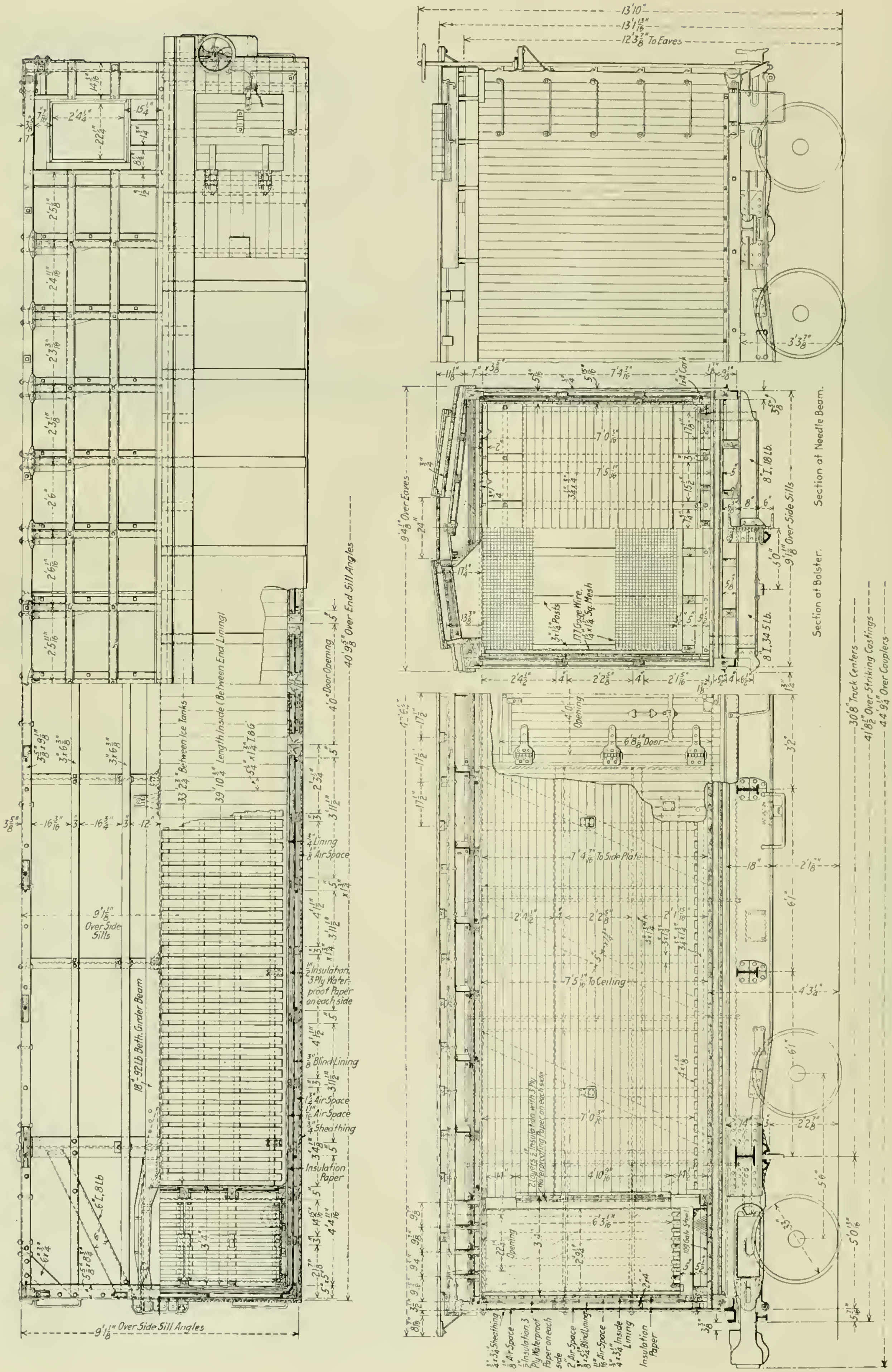
The center sills of the other underframe are built up of 5/16-in. web plates with 3-in. by 3-in. by 5/16-in. angle flanges at the top on the outside only and 3-in. by 3-in. by ¼-in. angle flanges on the inside and 3-in. by 3-in. by ½-in. angle flanges on the outside at the bottom of each plate. The sills are completed with two ¼-in. superimposed top cover plates, the lower one extending the entire length of the sills and the other extending 8 ft. toward each end from the transverse center line of the car. The bolsters on this underframe are also of built up box section; the 5/16-in. web plates are spaced 8 in. back to back and reinforced with 2½-in. by 2½-in. by 5/16-in. angles on the outside at both top and bottom. The bolsters are completed with top and bottom cover plates, the latter being continuous and are attached to the center sills on either side with one horizontal and two vertical corner angles.

In other respects the two underframes are similar. Both have four 8-in., 18-lb. I-section needle beams, and in each case the end and side members are 4-in. by 4-in. by ⅜-in. and 4-in. by 3-in. by ⅜-in. angles, respectively.

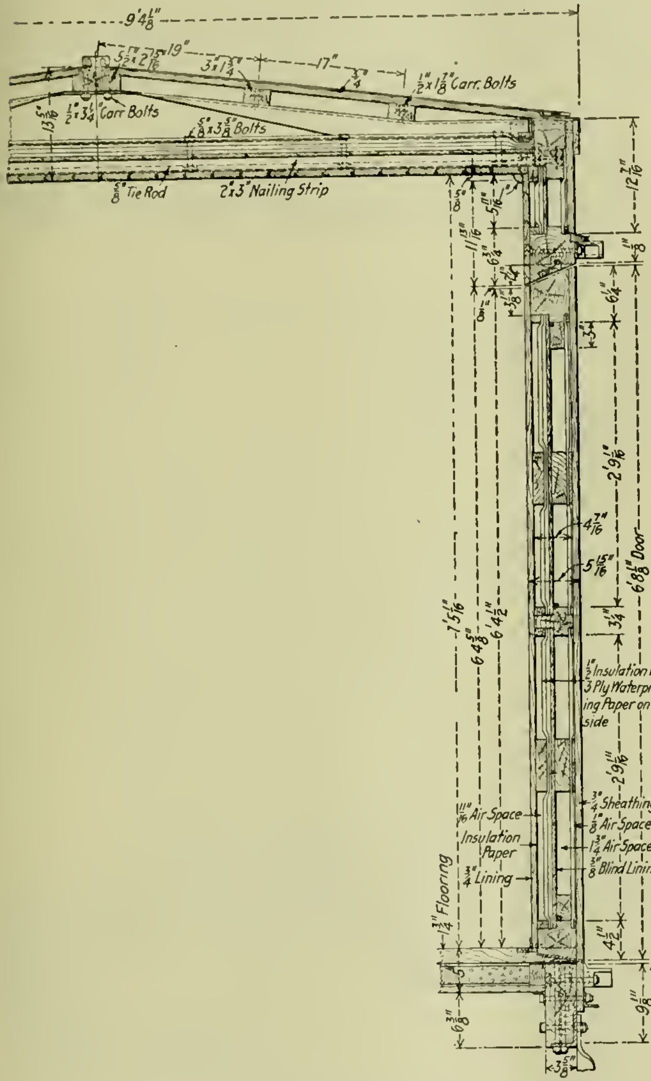
The Car Bodies

The construction of both car bodies is essentially the same. Both have wood frames with the exception of the carlines, which are of pressed steel. The bodies are built up on wood sub-sills; those for the sides and ends are framed into and bolted to the angle members of the steel underframe; while the intermediate sills are bolted on top of the needle beams.

The entire floor construction is placed above the inter-



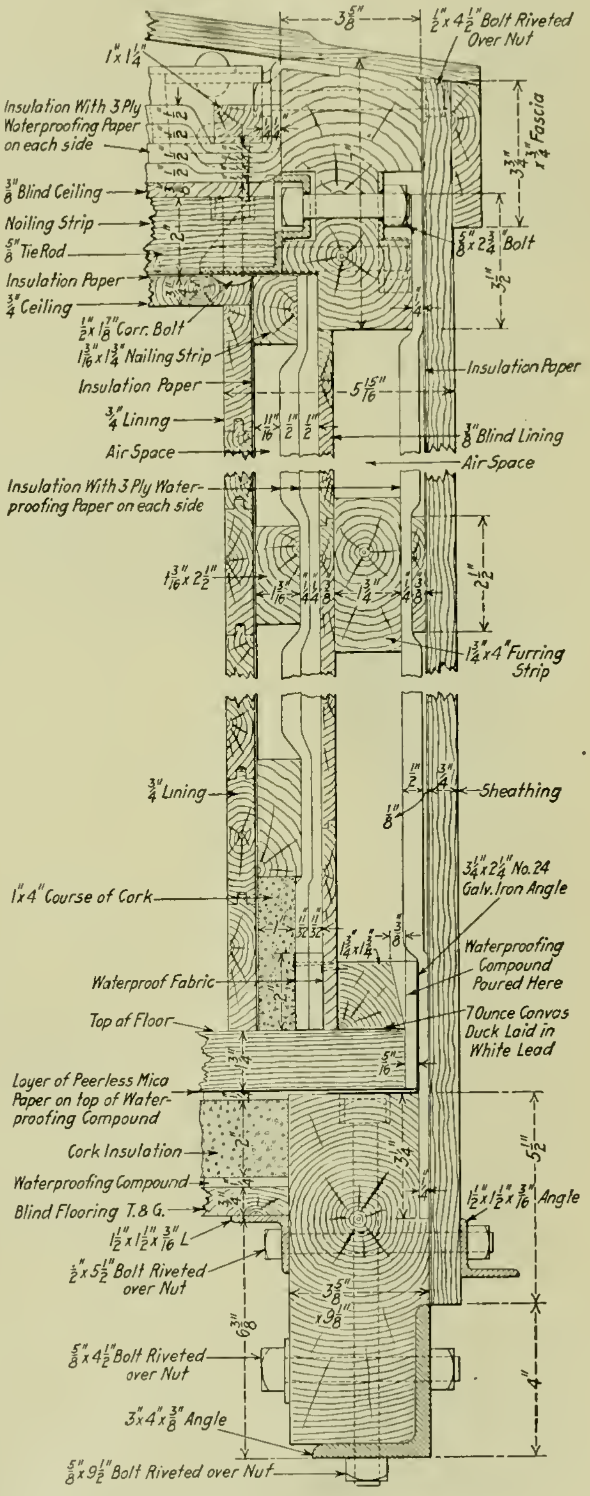
General Drawing of the Pacific Fruit Express Ventilator Refrigerator Cars, with Bettendorf Underframe mediate sub-sills with no enclosed air spaces, which makes it possible to provide continuous floor insulation. The lower floor is ¾-in. tongued and grooved material nailed directly to the top of the intermediate sub-sills, the ends of the boards resting on 1½-in. by 1½-in. angle supports bolted to the inside faces of the side sub-sills. This floor is covered with a ¼-in. coat of Sarco Bituminous Seal, applied hot. A 2-in. course of Nonpareil Cork Board is then laid while the bituminous compound is still hot and this is sealed with another ¼-in. coat of the hot waterproof compound. The insulation thus built up is covered with a layer of Peerless mica surfaced insulating paper with the seams carefully joined to prevent moisture passing through and the upper floor, of 1¾-in. tongued and grooved material is then laid. The ends of the flooring are nailed to the tops of the side sub-sills and the boards are further secured by nailing through the insulation into the two center sub-sills.



Cross Section of the Car Body at the Door

The side construction provides three air spaces between the inside lining and the sheathing. The first course of insulation, consisting of one layer of ½-in. Keystone hair felt between courses of three ply, waterproofing paper is placed outside the frame before the outside sheathing is applied. This insulation, as is shown in one of the drawings, extends continuously from door post to door post around each end of the car and is secured to the frame members by ⅜-in. nailing strips. After a layer of Per Bona insulating paper, also extending continuously from door post to door post, has been laid over the nailing strips, the sheathing is applied. There is a nominal air space of ⅛-in. between the unrestrained portions of the insulation and the sheathing.

An intermediate lining of ⅜-in. ship lap material is nailed to the inside of the frame members, and against this is laid the inside insulation, consisting of two thicknesses of the hair felt covered on each side with three-ply waterproofing paper. This extends continuously around the ends of the car from door post to door post, and is held in place by 1-3/16-in. nailing strips over which is placed a continuous covering of Per Bona insulating paper before the inside lining is applied.



Section Through the Side of the Car, Showing Details at the Junction of the Side With the Ceiling and Floor

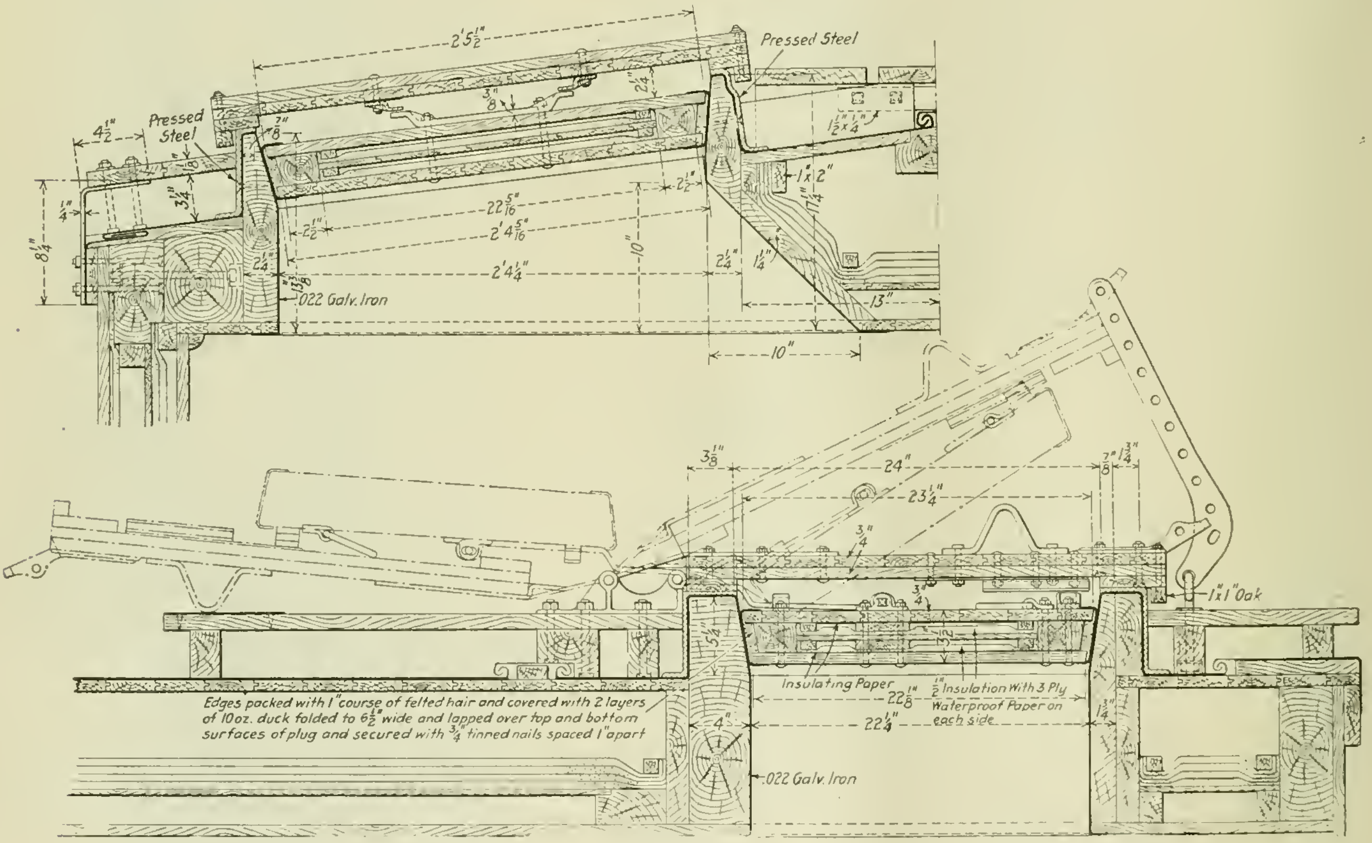
In the bottom of the side and end walls, a strip of 1-in.

by 4-in. cork board is laid on top of the floor between the inside lining and the inside layers of insulation. This is held in place against the floor by a 1-3/16-in. belt strip placed directly above it. To further protect the insulation and the concealed wood work at the floor line from the penetration of moisture, the lower edges of the two inside layers of hair felt are enclosed in a waterproof cotton fabric placed under the edges of the insulation and folded up the sides for a distance of two inches above the floor; the nailing strips for the blind lining at the floor are covered with canvas laid in white lead on the floor and lining sides, and the 5/16-in. spaces between the ends of the floor boards and the outside faces of the side sills are filled with hot waterproofing compound extending up $3\frac{1}{2}$-in. to the top of the blind lining nailing strips. The doors are built up with the same arrangement of insulation as that in the sides of the car. They are fitted with Miner fasteners and insulation for the joints between and around the doors.

The Roof

The cars are fitted with the Murphy X L A outside metal roof and, with the exception of those at the ends of the hatchways, the car-lines are of pressed steel of inverted U-section with one side extending down to form a support to which the ceiling structure is bolted.

The roof insulation consists of four layers of the $\frac{1}{2}$-in. hair felt insulation, covered on each side with three-ply waterproofing paper. This insulation is placed between the steel car-lines and the blind ceiling, which is built up of $\frac{3}{8}$-in. ship lap material on top of 2-in. by 3-in. transverse nailing strips. On the lower face of the nailing strips the $\frac{3}{4}$-in. tongued and grooved ceiling is applied and the whole structure is secured to the car-lines by $\frac{5}{8}$-in. bolts.



Edges packed with 1" course of felted hair and covered with 2 layers of 10oz. duck folded to 6½" wide and lapped over top and bottom surfaces of plug and secured with ¾ tinned nails spaced 1" apart

Transverse and Longitudinal Sections Through the Hatch, Showing Method of Ventilating the Car

The details of the construction of the hatchway openings and the methods of securing the insulation at these points are shown in the drawings. The hatch covers and plugs are both hinged from single sets of hinge fixtures with separate hinge connections and they are arranged so that the hatches may be opened for ventilator service. The cover is held open by a simple adjustable support and the plug is supported from the cover by a sliding attachment, normally not connected, but easily brought into play when both are fully opened.

The Bunkers

The bunkers are enclosed by a bulkhead, the outside face of which is 3 ft. 4 in. from the end lining. The bulkhead is built up on 3-in. by 4-in. oak posts and consists of two courses of $\frac{3}{4}$-in. tongued and grooved material separated by two $\frac{1}{2}$-in. thicknesses of hair felt insulation covered with three-ply waterproofing paper. The first course is laid against nailing strips between the posts and the outer course is nailed directly to the faces of the posts. The top bulkhead opening is 14 in. deep and the bottom 12 in.

The ice tank is fitted with a floor pan of galvanized steel and the lining of the end and sides of the car is covered with galvanized iron from the floor pan flashing to the ceiling.

The galvanized wire ice basket is spaced $1\frac{1}{2}$ in. from the end lining, $1\frac{5}{8}$ in. from the side linings and is attached directly to the inside faces of the bulkhead posts. The bottom of the basket is closed with an oak grate made up of $3\frac{1}{2}$-in. by $1\frac{1}{2}$-in. bars extending across the car and supported on six supports of 3-in. by 5-in. oak, the tops of which are $10\frac{1}{2}$ in. above the floor.

The floor racks are built in two longitudinal sections at each end of the car, hinged at the sides to swing up against the lining. Each section is supported on four $1\frac{3}{4}$-in. by $3\frac{3}{4}$-in. longitudinal members and is made up of $1\frac{1}{8}$-in. by 4-in. boards spaced 1-9/16-in. apart.

The trucks on the cars with the built up underframes have Vulcan side frames and Buckeye bolsters, the ends of which rest on Barber roller spring seats. The axles have 5-in. by 9-in. journals and the trucks are fitted with Creco No. 2 brake beams.

Annual Report of the Chief of the Bureau of Safety

Defective Air Brakes Still Constitute Majority of Safety Appliance Defects; Two Devices Tested

The percentage of cars found defective, as shown in the annual report of the chief of the Bureau of Safety for the year ending June 30, 1920, is higher than any of the past five years. However, there is some improvement in the statistics of casualties to employees for the year 1919 as compared with 1918. The recommendations made by the chief of the bureau in previous years regarding the maintenance of air brakes and the control of freight trains on heavy grades by air brakes exclusively are repeated. A brief summary of the report is given below.

Safety Appliances

The following statement affords opportunity for ready comparison of the results of inspections with previous years. It has been compiled from the figures for the fiscal years ended June 30, from 1915 to 1920, inclusive.

	1916	1917	1918	1919	1920
Freight cars inspected...	993,566	1,100,104	1,059,913	1,023,942	864,775
Per cent defective......	3.72	3.64	3.92	3.7	4.59
Passenger cars inspected.	27,220	29,456	25,732	23,712	19,849
Per cent defective.......	1.82	0.85	0.56	0.39	0.77
Locomotives inspected...	31,721	37,199	33,806	30,707	23,883
Per cent defective......	3.66	2.69	2.18	1.84	2.38
Number of defects per 1,000 inspected	45.56	41.16	44.01	40.92	52.08

As shown by this summary, the number of cars inspected was less than for the preceding years, but the percentage for each class of equipment, as well as the number of defects found per thousand inspected, have materially increased. The decrease in the number inspected was occasioned by the numerous special investigations which the inspectors were called upon to make during the year, thus rendering it impossible to devote as much time as heretofore to regular inspection work. The proportionate increase in defects reported is attributed largely to the abnormal operating conditions which existed during the year, resulting in the use of equipment regardless of its age or condition and its continuance in service without necessary repairs, these conditions being aggravated by inadequate shop facilities and repair forces.

Of the total of 47,319 defects of all classes, 3,791 were to couplers and parts, 5,035 to uncoupling mechanism, 22,375 to air brakes, 4,049 to handholds, 1,940 to height of drawbars, 557 to sill steps, 1,444 to ladders, 2,399 to running boards, 5,507 to hand brakes, 36 to safety railings, 130 to footboards, 12 to pilot beam sill steps, 36 to handrails, 3 to steps for headlights, and 5 to power brakes on locomotives.

It will be noted that air-brake defects continue to represent by far the most numerous class. Nearly 50 per cent of all defects reported were to visible parts of air brakes, more than 20,000 of these defects being found in but five parts. The number of cars with brakes cut out of service continues unduly large. Of the 22,375 air-brake defects reported, 7,344, or nearly 33 per cent of the whole number, were cut-out brakes. At numerous terminals it is a common occurrence for cars with cut-out brakes to be made up in trains and permitted to depart in that condition, although facilities exist at such terminals for making necessary repairs to place all power-brake equipment in operative condition. This practice should be discontinued.

The condition of the air brakes in trains prior to departure, as ascertained by the commission's inspectors by means of terminal or standing tests, is tabulated in the report. This table shows the results of tests of 938 trains, composed of 30,578 cars. The brakes on 94.7 per cent of these cars were in operative condition when the trains tested departed from the terminals. Of the total number of cars, there were 5 nonair cars, 178 cars with the brakes cut out, and 1,431 cars on which the brakes did not apply, making a total of 1,614 cars on which the brakes were not operative when leaving terminals.

Another table represents the condition of the air brakes, as ascertained by the commission's inspectors by means of terminal or standing tests, upon arrival of trains at terminals. This table shows that in 149 trains, consisting of 5,819 cars, the brakes were operative on 88 per cent of the cars. Of the total number of cars in these trains there were 194 with the brakes cut out and 477 on which the brakes did not apply, or 671 cars with inoperative brakes. This table shows that of 41 roads on which arriving tests were made there were 14 on which trains did not have an average of 85 per cent operative brakes. It is apparent that the law is not being complied with as to the minimum percentage prescribed by the order of the commission of June 6, 1910, nor as to the requirement that all air-brake cars associated with the minimum percentage must also be used and operated. The arriving tests show the condition of air-brake equipment from a practical operating standpoint. Carriers should take necessary measures to insure strict compliance with the law and see to it that trains at all times are operated not only with the minimum percentage of operative brakes specified by law, but also with all associated air brakes used and operated.

On March 2, 1920, application was filed by the American Railroad Association for a further extension of time within which to equip cars in service on July 1, 1911, to conform to the standards of equipment prescribed by the commission's order of March 13, 1911. This application for an extension of time was denied by the commission on August 7, 1920.

The report calls attention to violations of the Safety Appliance Act occurring at interchange points. One carrier delivers cars to another with defective safety appliances and the receiving carrier moves the cars to its yard, thus making two violations of the law. Adequate inspection and proper repairs prior to assembling cars for interchange movement are recommended to eliminate this difficulty. The practice of permitting defective cars to accumulate and making them up in a train for movement to a repair point is also condemned. Recently two suits were instituted against carriers for movement of trains of this nature.

The handling of logging trains is again referred to and the chief inspector states, in view of the conditions existing, the law should be amended by placing further restrictions upon the operation of such trains.

Mention is again made of the handling of trains down heavy grades by means of hand brakes supplemented by air brakes. Suits are being instituted for the purpose of compelling strict observance of the law. A statement is made that controlling trains by air brakes alone is the safer and better practice and is dependent merely on proper maintenance of air brake equipment. Defective hand brakes are also mentioned as the source of many suits.

Summary of Casualties

The casualties on steam railroads in connection with the operation of trains during the calendar year 1919 are summarized in the table shown on the following page.

In addition there were 483 persons killed and 96,452 injured in nontrain accidents during the year, in comparison with 589 killed and 110,431 injured during the previous year.

During the calendar year 1919 there were 108 employees killed and 1,975 injured in coupling or uncoupling locomotives or cars, as compared with 164 killed and 2,332 injured during 1918. Casualties to employees in 1919, due to coming in contact with fixed structures, resulted in 56 deaths and 1,009 injuries, the corresponding figures for 1918 being 83 and 1,367. In 1919 there were 97 employees killed and 6,219 injured in getting on or off cars or locomotives.

	Number of persons	
Class of persons	Killed	Injured
Trespassers	2,553	2,658
Employees	1,759	36,601
Passengers	273	7,456
Persons carried under contract, such as mail clerks, Pullman conductors, etc.	28	691
Other nontrespassers	1,882	5,195
Total of above classes	6,495	52,601

During the year ended June 30, 1920, 90 train accidents were investigated by this bureau, consisting of 58 collisions and 32 derailments. The collisions resulted in the death of 179 persons and the injury of 1,158 persons; the derailments resulted in the death of 60 persons and the injury of 481 persons, a total of 239 killed and 1,639 injured.

Investigation of Safety Devices

During the year tests were conducted of the device of the United States Train Signal Co., of Portland, Me. This device is an electropneumatic signal system providing means of transmitting signals between the cars and the locomotive in a train, and vice versa. It consists of electropneumatic valves controlled by a series circuit, one valve being installed in each car or locomotive cab, and provided with indicators, both audible and visual, which are operated when the circuit is interrupted; circuit controllers for operating the device are provided in each car and locomotive. The examination and tests of this device demonstrated that visual and audible signals, which are displayed and sounded simultaneously on each equipped vehicle, can be transmitted as rapidly as the circuit controller can be operated; and signals can be acknowledged by engine crew or transmitted from engine crew to train crew without the use of the locomotive whistle.

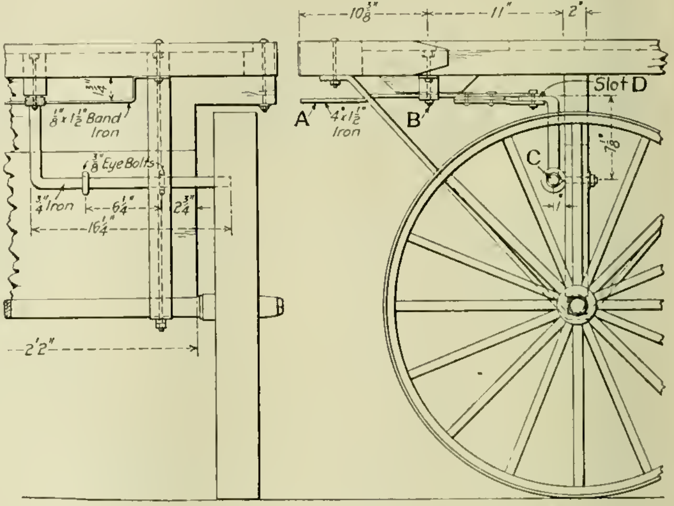
An inspection has been made and demonstrations witnessed of the automatic connector of the Robinson Connector Co., New York, N. Y., as installed on passenger equipment of the New York Central operating between Dunkirk, N. Y., and Titusville, Pa. This connector is of the butt face, straight port type, with wing type guiding members, which form the gathering and registering devices. As a result of the inspections and demonstrations of this device, the Robinson connector is considered well adapted to accomplish its intended functions when used on passenger-train equipment. The few irregularities of operation noted during these demonstrations were without exception due to details of construction and installation which can readily be improved. The use of gaskets of special design is undesirable from an operating standpoint. It is believed the gathering range and registering means employed by this device are adequate and reliable and that with this connector tight joints can be maintained.

Preliminary steps have been taken and plans are being formulated for the administration of section 26 of the interstate commerce act, conferring upon the commission authority to require the use of automatic train stop or train control devices and other safety devices in designated locations and to prescribe specifications and requirements therefor.

The report includes the usual tabulation showing the results of the inspection of safety appliances and tests of air brakes on trains arriving at and departing from terminals. Numerous judicial interpretations of the safety appliance law are summarized in the report.

Locking Device Applied to Station Baggage Trucks

It occasionally happens that baggage trucks when left on slight inclines start of their own accord and occasion more or less damage by running into and injuring passengers. Sometimes trucks are started unintentionally by persons bumping into them. To prevent the possibility of accidental starting, a locking device has been developed and put into use on baggage trucks on the Chicago, Milwaukee & St. Paul. A sketch of the detailed application of this device is shown in the illustration. The lock *C* consists of a piece of ¾-in. round iron, bent at right angles and guided by two ⅜-in. eye bolts. In order to lock the truck this iron is extended between the wheel spokes, and when moved back out of the way the truck is unlocked and free to move. Movement of the locking bar *C* is controlled by the handle *A*, pivoted at *B*. The slot *D* prevents any binding action and the handle *A* moves freely when it is desired to lock or unlock the truck. The handle *A* is supported by and slides on a band of ⅛-in. by 1½-in. iron. The entire locking device is under the truck, out of the way, and has proved most efficient for the purpose for which it was designed.



Locking Device Applied to Chicago, Milwaukee & St. Paul Baggage Trucks

The Main Shop of the A. E. F. at Nevers, France

An Efficient Car Straightening Frame

Counterweighted Jacking Beams, Power Jack and Winch Facilitate Work on Steel Cars

BENT end sills, bulged sides, damaged corners and buckled cars are bugbears for shops that repair steel freight equipment. Sledging or jacking the parts into position involves much hard work and oftentimes an indifferent job results. Jacking frames are now widely used for stresses when pulling or jacking with the car blocked against the frame. A general view of the stall is shown in Fig. 1 while Fig. 4 shows the details of the structural work. Figs. 5 and 6 show the appliance used for straightening by means of an air motor which forms the unusual feature of this installation. In straightening the bent parts of cars, the jacks or blocks are placed against movable horizontal jack beams.


Fig. 1—Jacking Stall at Avis Shops, Showing Jacking Bars and Power Operated Jack

this class of work and with good success. To facilitate the operations performed with this appliance, N. B. Messimer, superintendent of the Avis, Pa., shops of the New York Central, devised an ingenious arrangement for using a power jack.


Fig. 2—A Badly Buckled Car as Received for Repairs


Fig. 3—Car Shown in Fig. 2 After Being Straightened

The jacking stall itself consists essentially of a structural steel framework of sufficient strength to withstand the

The side jack beams are made of two 8 in., 16.75 lb. channels riveted to spacing blocks, each of which has a 1¾ in. rod extending between the vertical posts. By tightening the nuts extending between the vertical posts of the jacking frame.

on these rods, the jack beams can be securely held in position. The end jack beams are of similar design; but since the distance between the center of the posts is greater, they are made of 10 in., 30 lb. channels. Each jack beam is counterbalanced by two weights attached to wire ropes which pass over sheaves keyed to a 1¾ in. shaft mounted above the top tie beam as shown in Fig. 4. This facilitates raising or lowering the jack beam and keeps it horizontal.

On the jack beam is mounted a pneumatically operated jack as shown in Figs. 5 and 6. This consists of a train of gears driven by an air motor and operating a large gear having a recess in the hub for a 1½ in. hexagon nut and a two-inch hole through the center of the gear. A threaded keybolt is passed through the gear and between the two channels of the jack beam. Various hooks for reaching across the car, around end stakes, end sills, etc., are readily attached to the end of the keybolt by a loose key, after which the nut is inserted in the recess in the jack gear.

The frame holding the jack gears is fitted with rollers which run on the upper flange of the jack beam and clamps by which it can be locked to the lower flange. In straightening the cars, the jack beam is placed adjacent to the part where the stress is to be applied and it is blocked in such a manner that by pulling with the power jack, the part can be straightened. Journal jacks are often used for blocking the cars and these have lugs welded to the base by which they are held to the jack beams.

Bad kinks, as for example a crumpled corner, require heating, after a strain has been imposed, to insure a good smooth job. The majority of straightening, however, can be done cold by properly blocking the car or portion of the car being worked upon and then pulling with the motor gear box or jacking with ratchet jacks.

That this car straightening jack will take care of the big job as well as the small kinks is evidenced by the repairs to a steel gondola which was badly buckled in a wreck. This gondola (Fig. 2) was placed upside down on a pair of trucks for convenience in working and run into the straightening

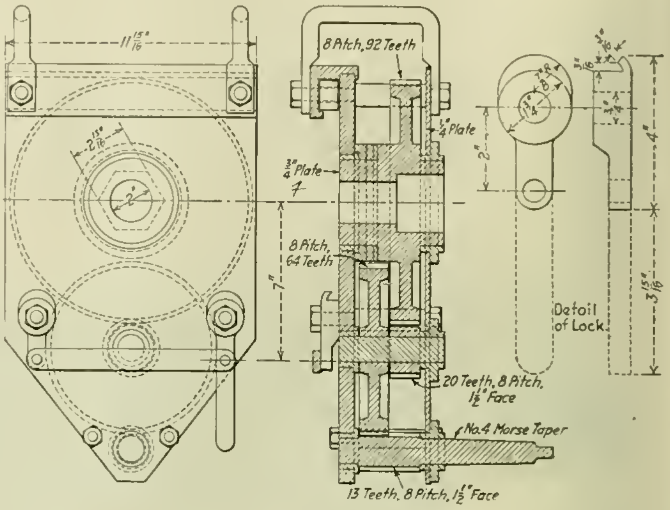


Fig. 5—Details of the Jack Gear

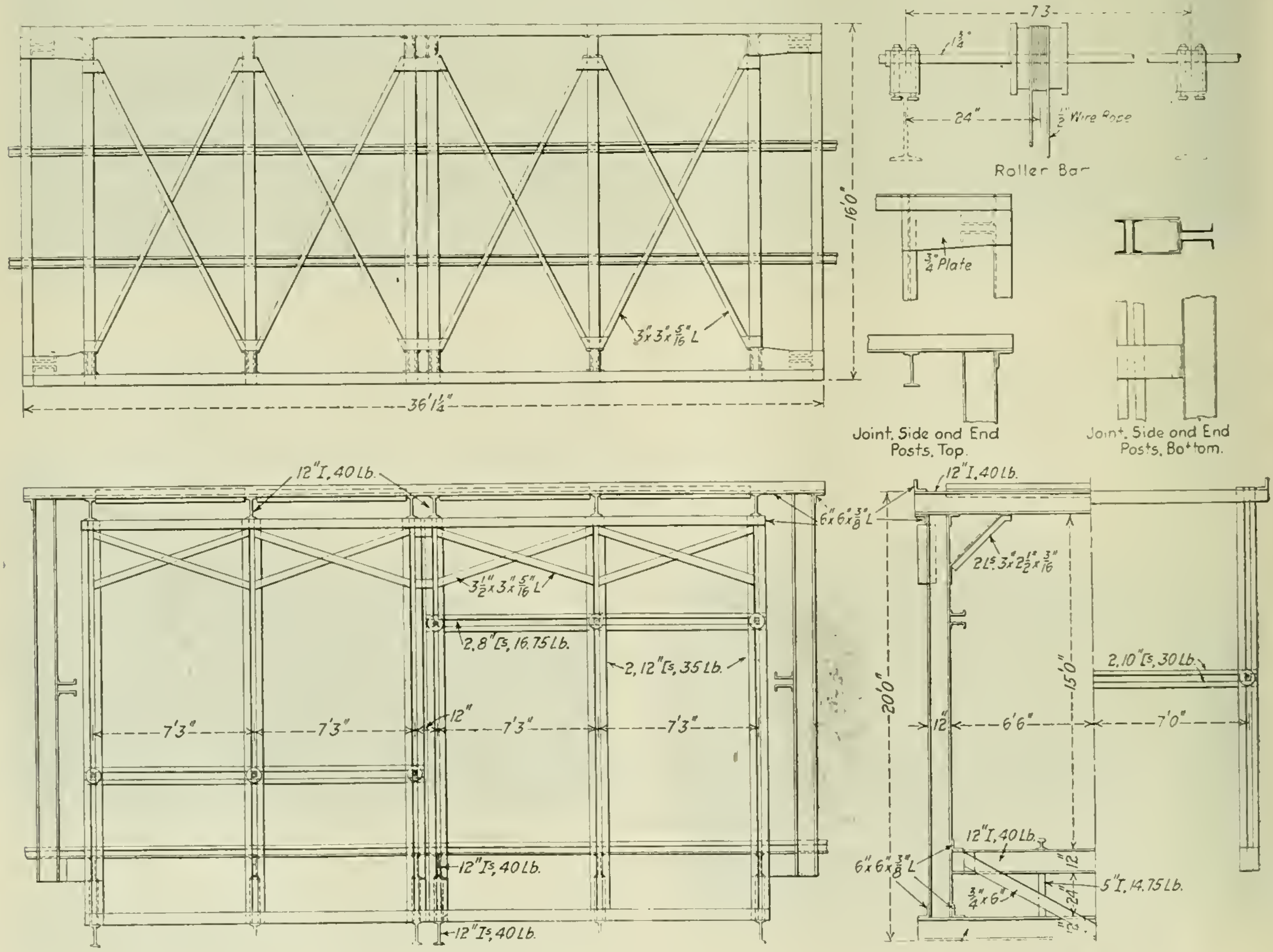


Fig. 4—Assembly Drawing of Jacking Stall Showing Arrangement of Structural Steel Parts

frame. The car straightened and ready for service is shown in Fig. 3. Close inspection will show the reinforcing angle along the top of the side, the use of which has been found to be advisable in stiffening a badly crumpled sheet. While this method of straightening avoids the bad effects of heating sheets, a sheet that has been bent is not as stiff or strong as the original plate; consequently, this stiffening angle is often added after straightening.

Fig. 6—Power Jack in Position to Straighten the Side of a Hopper Car

An interesting device used in connection with the jacking frame is the motor winch shown in Fig. 7. This is located beside the track at the end of the stall and is used to pull cars by means of a rope passing around a sheave which is driven through gearing by an air motor.

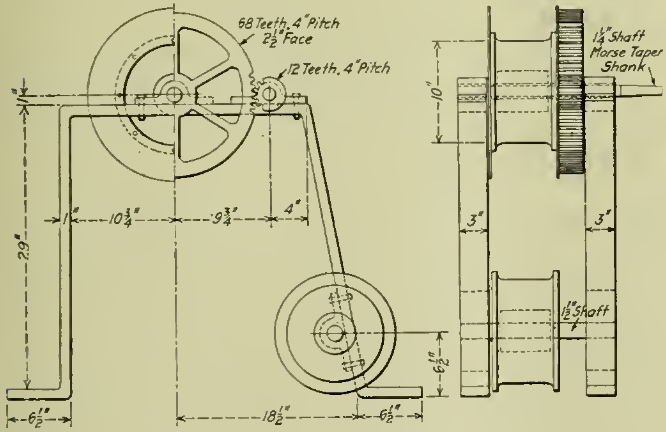


Fig. 7—Winch for Pulling Cars Operated by Air Motor

Preventing Theft from Freight Cars.—There is one thing that would help to reduce theft and that is to make it physically hard to break into cars. The seal we put on a car door offers no resistance. The morale of the people who pilfer cars is not such as to deter them with merely a seal and, therefore, it would seem that physical resistance to their entrance to the car would offer us the greatest amount of protection.—*D. R. MacBain, before the Western Railway Club.*

Lubrication of Freight and Passenger Equipment*

BY M. J. O'CONNOR
Mechanical Inspector, New York Central

The subject assigned the speaker is fully realized as one of the most important subjects that the railroads have to contend with at the present time, and one of the most expensive in the operation of their trains, both passenger and freight. My experience as a special lubrication inspector for the past twelve years with the New York Central Lines, leads me to believe that we should not take any radical action in the handling of lubrication without careful and due consideration, especially after we have proven that the methods shown to be satisfactory are in vogue.

The practices of the trunk lines that I have the honor to represent are more or less, briefly speaking, as follows:—The journal box packing used by our company is prepared on a standard 48 hr. basis for saturation. The equipment used in connection with this material consists of metal tanks equipped with screens located about two inches from the bottom and is fitted with 1¼-in. faucets which are used in draining off the surplus oil which is placed in the tank during the process of saturation. For example, we place 50 lb. of dry waste in the tank and submerge same in 60 gallons of oil. After same is thoroughly saturated in accordance with our standard practice, we drain off 35 gallons of oil, thus leaving 25 gallons of oil, or four pints of oil for each pound of dry waste so saturated. The draining off of this surplus oil automatically makes the preparation tank a storage tank and the faucet is then used for drawing off the oil that settles in the bottom of the tank. This oil is poured over the packing several times daily until all of the material is used. By this method, we are reasonably sure that such packing contains four pints of oil to each pound of waste when placed in journal boxes under cars.

It is not our custom to use any free oil in the handling of freight trains as prepared packing is used almost exclusively in shops, terminals and enroute in trains.

The packing that we use and from which excellent results have been obtained, also a much better service performance, consists of a cotton-wool mixture, which is our standard journal box packing at the present time. Briefly outlined the reason for favoring the combined cotton-wool preparation, is the fact that our men know at all times when adjusting the packing in the boxes on cars in trains whether or not it is carrying sufficient oil, which cannot be determined with the all-wool waste so readily, for the reason that the wool waste will not hold the oil in suspension, thus depriving the metal of the proper lubrication that the combined cotton-wool waste gives it on the start.

Many papers have been prepared on this most important subject, and the idea is that the discussion will bring out many points of interest that I shall be very glad to reply to when propounded.

The mileage on the system that I represent runs on an average as follows:

Freight—31,000 miles per car per hot box for the year 1919.

Passenger—170,000 miles per car per hot box for the year 1919.

The figures shown for the passenger performance represents mileage on the very highest class of trains. The service performance on our local passenger trains was still better and averaged more than 650,000 miles per car per hot box during the year 1919.

With reference to the freight car performance, we averaged approximately one hot box on less than one-quarter of one per cent of the cars handled during the year 1919.

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*A paper presented at the convention of the Chief Interchange Car Inspectors' and Car Foremen's Association.

I sincerely hope that the points brought out fully meet the question and will cause an extensive discussion for the welfare of the service throughout the United States and Canada.

Discussion

B. F. Patram (Southern): We have what we term standard saturation tanks, with faucets. We have a tank that holds 50 lb. of dry waste which is saturated with 60 gallons of oil. We leave it for 48 hours or longer, sometimes a week, then draw off 35 gallons of the oil. As the material is used the effort is made to maintain the proportion of four pounds of oil to one pound of waste.

T. S. Cheadle: What is done in reference to conserving the portion that is taken out on the repair track? Do you make any preparation to save it and bring it into a reclaiming plant? All packing removed from the boxes is put into a bucket, whether out on the line or in the shop. We have a form submitted each month. If we send to the station 600 lb. of packing, the report the first of the month shows that on one side and we show the amount of material disbursed or delivered. We have a column on the opposite side that shows the amount received and if we do not get back at least 75 per cent of the amount that we send out, we immediately get on the job and find out why.

A Member: How do you arrive at the average mileage per hot box? I understood one man to say they got 31,000 miles per hot box. How do you get the data from the various divisions and how are the reports made? What are hot boxes, when they are smoking or when they are blazing?

M. J. O'Connor: This performance record was based on any car that was rebrassed or repacked, whether it caused a detention of the train on arrival at the terminal or not. If we have to base that on failures, our performance would be nearly 60,000 miles.

B. F. Patram: There was a lively discussion at the A. R. A. convention about using a plug of waste in front of the journal or having it just packed flush with the end of the journal.

M. J. O'Connor: The standard practice on the railroad I am connected with is to leave out the so called plug. There has been a lot of agitation about the front plug. One fellow says if you do not put the plug in the front, you cannot keep the packing in behind the journal. The proper method is to place the roll in the back of the box and work it up evenly so that you do not have it up on one side more than on the other. It is there better to exclude the dirt. It is a very important thing and it is a hard matter to maintain when you have trouble out on the road. The proper method is to pack boxes so that there is a continuous feeding of the packing, so that when it is in, it is practically all in one piece. If it is put in properly, the only lateral play you will have, is the distance between the end of the journal bearing and the inside face of the journal. If it does extend out a little, after the car has gone over the division and shows indication at the next terminal point of working out, the car oiler, or whoever is looking after the journal boxes, knows that. If you have a plug in front, he does not know it. The only indication you have is when the collar of the journal has worked out into the packing. I know it will not work out sufficiently to cause any trouble. When we began the method of packing boxes by eliminating the front plug, we started it out on the very best trains.

T. J. O'Donnell: Do you feel that a practical lubrication man riding the trains is an advantage?

M. J. O'Connor: Absolutely. We are going to get more cars over the road with less cut-offs. It was really a matter of education to the men. If something happened and the car man was not at fault they might try to blame him just the same. In traveling around the very fact that you recognize his little complaints increases the co-operation. A man out on the road is of great benefit to the department, if nothing more or less than in the matter of education.

T. S. Cheadle: As I understand you pack without a front plug. When a car comes to you with a front plug in there, do you take it out?

M. J. O'Connor: No, not unless we change the wheels or bearings.

T. S. Cheadle: Lack of uniformity is giving us considerable trouble. The inspector cannot tell whether it is there for the purpose of forming a front plug. I do not think we can get much improvement until we have a uniform practice. I believe a letter ballot should be taken.

A Member: What system have you for treating hot boxes when delivered in interchange? At the point of interchange do you take care of the boxes immediately, or do you allow them to cool off?

M. J. O'Connor: The cars received in interchange are marked to the repair track. It is our practice in the terminals not to allow the men to use their own judgment.

C. E. LaMontagne (Rutland): We ran into quite an epidemic of cut journals at one of our interchange points in connection with your road, and I think the matter can be overcome if these boxes are treated, and a little oil or new waste applied to keep the journals from cutting, which is very expensive.

M. J. O'Connor: It is my opinion that where a journal becomes hot to the extent of blazing, there is no question about its being cut. Some roads cool it and pack it and hand it on to the other fellow. Let the man get that car in its original condition.

A. Kipp (N. Y. O. & W.): I understand Mr. O'Connor to say that they have two systems on the N. Y. C. of treating boxes: If a car comes in that had a plug in it, they put in a plug; if they didn't have a plug, they packed it without a plug. Do I understand correctly?

M. J. O'Connor: No. The question was: "Do we remove the plugs?" and I said "No." But if we change the wheels on a car or rebrass a car, we will not put the plug back in there.

C. E. LaMontagne: If a car delivered into a train from one connection to another has a hot box, don't you think that the box ought to get immediate attention?

T. J. O'Donnell: If we deliver 50 cars across the dead line to the delivering line and there is a car blazing, the car will be on the repair track in an hour and a half. That is the attention we give it.

C. E. LaMontagne: The point I was getting at is not to have the cars switching around.

T. J. O'Donnell: In our district it is all receiving line inspection.

C. E. LaMontagne: Couldn't a lot of these cut journals be eliminated if the boxes were taken care of at the time of delivery?

M. J. O'Connor: No, for the reason that the movement does not amount to anything. That condition exists when the car moves in the terminal.

G. Lynch: I would like to ask Mr. O'Connor if there is any attempt at uniformity of practice in packing boxes, and what he would propose as the best method.

M. J. O'Connor: There are representatives here of a few railroads that are packing boxes along the line that is standard with the New York Central. I think I outlined the method they considered proper; that is, placing the roll in the back of the box and feeding the packing in, not rolling it on the side. Some do not put any roll in the back at all. Then the box packer reaches down in a bucket and takes a handful and shoves that back, and he keeps on until he has the box packed in sections. The result is, if you have any lateral, which you have in most all boxes, the piece becomes dislodged and twists the next piece, and so on. How many men here have seen where lids were forced open? If it is packed in in a continuous strand, knitted together, you will never have that condition. That is a hard thing to accomplish. I am after that day after day, particularly when we put on new men. That is the first thing I look for. It is my duty to instruct them. In that way we have uniformity, and everybody in the car department, from the superintendent down to the doper, takes an interest in it.

G. Lynch: The important question is to get uniformity of practice on all railroads. I find there is nothing but individual practice, and I wonder if it would not be practicable to incorporate a rule in the book of rules, making it compulsory to pack in a certain way, whichever way it is decided best. I think your paper is very fine and your explanations good, but we have no uniform practice on the railroads. All of the railroads in the A. R. A. should get together and adopt some method.

M. J. O'Connor: That is one of the things I hoped somebody would talk about; that is the principal thing to do, and the other is a method of reclaiming journal box packing. The railroad I am connected with has spent thousands of dollars installing reclamation plants at central points to cover certain territories. The reclamation of packing answers two purposes. In the first place if a man reports to his general foreman "We repacked 90 cars last month, periodical packing and stencil," you will use in packing 90 cars, about 9,000 lb. of material, it runs about 100 lb. per car. If that man hasn't used 9,000 lb. of that material, you then know that some of that material removed was not sent in to be reclaimed. It is a check on the work and it also insures better service.

Mr. O'Donnell said on arrival in the terminal that an inspection was made for safety appliances. The car would then go possibly 15 miles to a receiving line, and it would then be given an inspection. On a car coming in with a box smoking pretty badly, the journal bearing ought to be changed if it must be done, in four or five hours. It is cool and may run over fifteen miles, but when it gets on the main line, the journal will be cut.

T. J. O'Donnell: You might just as well stop every 15 miles on a 100 mile division and poke your hook in the box. If the box is blazing, we will get it on the delivering line. What is the use of holding the train up?

A Member: The car doesn't have to be blazing to have a cut journal in the terminal before it is delivered to the connecting line.

T. J. O'Donnell: You do not see a blazing car going across a dead line once in two weeks. If you have a meat car it will be shipped across to the other fellow.

A Member: Is the use of free oil entirely eliminated on the New York Central or have the men access to it at certain interchange lines where you receive high class freight? Do you allow the use of oil at points where they receive meat cars in interchange? What method is used in taking care of these boxes?

M. J. O'Connor: We do not use any free oil on freight cars. The last place that was used was at Sixty-third street in Chicago.

T. S. Cheadle: Is it the fault of lubrication or the fault of the mechanical conditions of the brake that causes hot boxes?

M. J. O'Connor: Quite a percentage of hot boxes are due to mechanical defects. Some roads apply journals with white lead on them. One of the worst conditions is the hollow journal bearing wedge. We destroy thousands of these hollow back wedges when we find them worn flat. Wedges are supposed to have 1/16 in. crown at the top. The function it performs is to distribute the load evenly to the bearing. If some of the other railroads will get after it as we have, we will have less hot boxes.

G. Lynch: When a wedge is worn, do you have it replaced with a new wedge?

M. J. O'Connor: Yes, or a good second hand one.

G. Lynch: We have found that where the wedge is worn, and a new wedge applied, before the car runs 20 miles, that new wedge is often broken because of the uneven bearing, due to the worn condition of the box. Under such conditions the box should be examined to see what condition the roof is in and if worn badly, the box should also be removed and a new one applied with the new wedge.

M. J. O'Connor: The boxes that you have reference to have had a wedge in with four pockets, some with two pockets, and instead of having 1/16 in. crown spread over the entire radius of the wedge, you have only that little bar. That is what wears the roof of the box. Where a solid wedge with a steel back is used I have never yet found them broken. Our standard is the solid back wedge and has been for three years.

A Member: Does the New York Central line confine the use of reclaimed packing entirely to its own cars? In repacking passenger cars do you use reclaimed packing?

M. J. O'Connor: Reclaimed packing is used on passenger cars the same as on freight. We found out when we had a high grade wool waste, it would not hold oil in suspension, particularly if the strands were more than 14 or 18 in. in length. With new waste, heat is required to saturate the oil.

A. J. Baumbush (N. Y. C.): At Grand Central Terminal we noticed that all of the boxes that were packed with new long wool waste were running hot. We tried using half cotton and half wool waste and found the journals ran cool. We are taking half wool and half cotton now, the majority new waste mixed in with the old. Our hot box trouble at Grand Central Terminal is almost gone. We do experience some hot box trouble when we do not catch them in time. The majority of the trouble is with cracked linings.

It is important for the car packer to use a knife on both sides of the box to crowd the loose ends down because when the brakes are applied, the journal picks up the loose ends. I guarantee if you leave the front plug out and the journal is all right, you will not have any hot boxes.

Mr. Clair: I have spent the last seven years to determine the best method of lubricating journals. I visited the railway waste plants throughout the country, with a view to getting journal box packing up to specifications. Unfortunately, it is a fact that the personal element enters into it and we have never been able to get a standard journal box packing. An honest endeavor was made to standardize the journal box packing. The problem was whether it would be cotton or wool or a mixture of both, which meant that some grades should be eliminated—these things which enter into journal box packing under the guise of waste materials.

Cotton and wool are considered to be the essential elements that might enter into the thread and yet there are many railroads calling for one hundred per cent wool and material is being accepted when there isn't one atom of wool in it. Often in treating waste to find out how much wool there is in it, everything in the shape of animal matter is credited as wool. There are some specifications which call for all wool waste long threaded stock. The threads might have been two miles in length if they were spun for journal box packing. It is bought for wool but it is cattle hair and steer hair, with nothing to bind the materials together except fuel oil. The hair that comes off of the back of sheep runs in lengths from two to ten inches and that is what you want in journal box packing. You do not want long threads, but you do need long staples. Sheep wool is covered with minute scales, similar to the back of a fish. When they are spun together they form a thread and if you take the thread and endeavor to separate it, you will find that it holds together. If you take the so-called red yarn and pull it apart, you will find the staples in the spinning similar to that spun with fuel oil which is worth two cents a pound for journal box packing.

The journal box packing should be cotton or wool, or something mixed together; it should be certain grades of cotton and certain grades of wool; not all good but there should be nothing put in there that was not calculated to lubricate the journal. We refused muck yarn, but after it was dyed red and filled with mineral matter it was accepted. The reason that the long threads of wool did not function in our boxes, is that they were not wool and were filled with a mineral dye to make them look better. Two years and a half ago, we got 200,000 lb. of cotton, and found that it had been loaded with water glass or sodium silicate. The staples are bound together with starch in order to weave sheets. When potatoes rose in price, water glass was substituted and that was the material that was entering into practically all journal box packing.

It is well to understand the journal box packing that you are getting. Some of the waste industries are nothing more than rag industries. There is one concern that takes old felt hats and that refuse goes into journal box packing. Until the United States Railroad Administration undertook to define these particular things which should not enter into journal box packing, they tried to eliminate them by stating that packing should be true fleece wool. Leave it up to your inspectors to go into the mill and analyze the material to see that it is true fleece wool. Material that comes in such long threads is not waste material. It is hair taken off the backs of cattle and spun for journal box packing. If you take the oil out of it, you will find it is a decidedly choppy mass of hair.

It is necessary to take such materials as can be produced in quantities. A proper source of material would be mills that weave overcoats, blankets, carpets and some tapestry. A source of materials for the cotton should be confined strictly to mills that produce shirting and some of the high grade linens. The cheap American cotton cannot be produced without putting potato starch in. Avoid the use of jute absolutely and specifically. The cheap grades of carpet are made out of jute and when treated it rots and becomes a powder. The shredded stock is used in order to cheapen it and it is well to get away from it.

I believe the day is not long distant when each and every railroad will honestly say to itself, "When we buy cheap materials for journal box packing, it would be better if we would adopt some standard, all good wool or all good cotton. Let it remain a waste problem but let everyone for once and all decide what it is which constitutes a standard journal box packing."

There are some roads that pay 30 cents a pound for journal box packing; it is not worth it. The cotton that enters into an honest journal box packing is worth 14 cents a pound, and when material sells for 10 cents, you will find that it is sweepings. That was my experience after having made a study of what honestly would constitute journal box packing of good quality that might be produced in a tremendous volume and uniform quality.

Mr. Geiser made some good tests. They were able to calculate how much oil was necessary to lubricate a journal, and it only took 5 per cent of the oil that was in the waste. We were looking for a journal box that would hold four pounds of oil per packing; it was too much. There are those who say the use of free oil is improper. They think they save money by not using oil and they do not think they pay 15 or 10 cents for the waste and burn it up without securing lubrication.

Reclaiming pays but not the reclamation that necessitates the erection of a $10,000 building with its equipment. But the conservation of waste material when you take out good journal box packing that is not all choppy, and shake the dirt out of it, if there is any in it, saturate in oil and put it back into the box is a good thing. But in the reclamation that necessitates some one saving it, it does not pay. If it is good waste it is fit to go back into the box. If it is bad waste, it ought to be destroyed right there. There is lots of money wasted by saving bad waste. Today waste is billed in accordance with the specifications that the threads should be clean, long, strong, true fleece wool. Other specifications say it must be long strands, none shorter than 18 in. in length. Good wool comes from mills and is honest waste material. The stuff that is long is not waste. It is spun for journal boxes; it looks good but you will find it is not at all satisfactory.

Another peculiar thing is that wool is necessary. Wool does not lubricate; it is cotton that lubricates, but it has to be good cotton. If it is foreign it is better. The test of the thread that enters into a journal box packing should be its fineness. When the staples are long you can spin the thread as fine as a needle and that is good. When the thread is thick the staples are short, and that is bad material. It is true of cotton, a thread spun 120 will not measure over 0.003 in. in diameter, but it is good cotton. The test of high quality is not length; if other things are equal, it is thinness of thread.

Another thing that serves no function is the flyings. There is no reason why anybody should take anything that looks like feathers and mix it in a journal box. If your specifications insist on cheap material, you have got to go to the cotton mills and buy the sweepings from the floor for 3½ cents a pound and introduce it into the journal box packing in order to sell it. It will require 2½ lb. for a journal box of 3½ cent cotton. It is cheaper to use the cotton than wool. Your journal box packing costs 15 cents and the lubricating oil is worth about 2 cents, and if you are not careful you will get 10 per cent lubricating packing; you do not get packing, you get oil. Look out for the waste that is saturated with oil. The functions of the journal box packing are first to hold the oil and then to feed it.

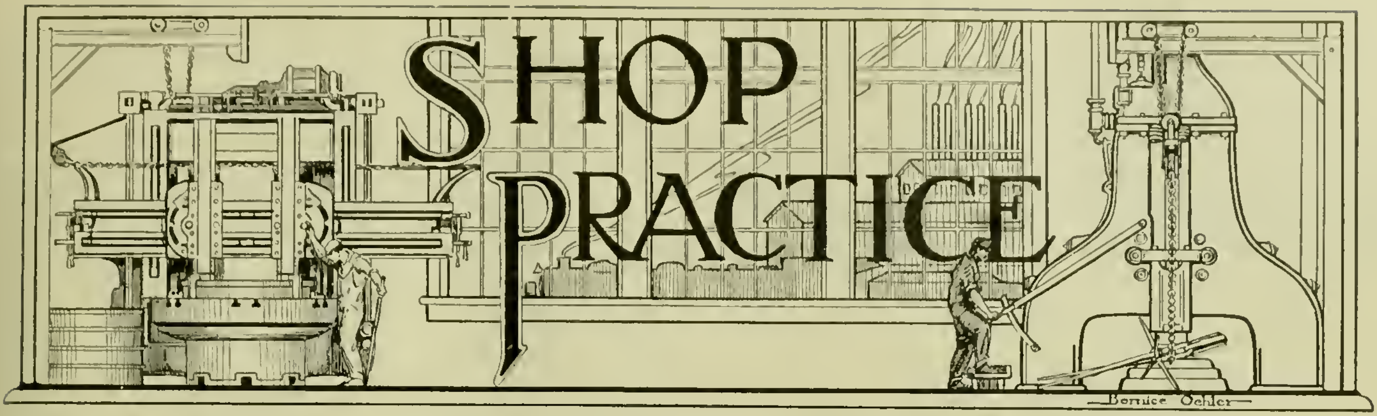
Cotton and wool combined do not afford elasticity to overcome the shocks and keep it up against the journal; you have got to impart some elasticity.

The best method of packing journal boxes in my mind is twist a rope and put it back against the mud guard, and put the biggest wad of packing that you can get in that box; take these threads and fold them over and under and put one piece of journal box packing in the box. The use of the plug is a disputable thing. If there is no plug in the front, the face of the journal will present one thing in vision; if the box is running hot the center of the journal will be dry. If there is a plug there you won't see whether the journal is running hot or not. Whether it is a good thing to offset your lateral motion, I do not know.

Avoid the use of what you call wipers. A piece of waste as big as an egg will wipe the oil off before the oil hits the brass. One little piece of waste improperly placed in that box will give trouble. Keep the little pieces of waste buried down; do not let them get on top of the journal box or there will be trouble.

F. W. Trapnell: This is a subject that has brought out a lot of discussion before in the A. R. A. convention, but I believe that those of us who are here have received more benefit from the discussion relative to the maintenance and packing of journal boxes that we ever got at Mechanical Section No. 3, because we have got right down to the ground floor of the work, as it ought to be done.

I am sure it is a pleasure to listen to Mr. Clair and to the reading of the paper by Mr. O'Connor. They have made it very plain and explicit to us. I move that a vote of thanks be extended to Mr. O'Connor and to Mr. Clair. (Seconded and carried.)



Belt Service and Length of Life

BY F. D. RICH

Sales Engineer, Crescent Belt Fastener Co., New York

Cutting the ends of a belt seems such a simple operation that often the belt man does not give it the consideration necessary to secure the best results, and much of the difficulty with otherwise good belts is due to their not being cut and joined accurately. With proper care, it is easy to make a belt joint which will run the same as an endless belt.

When a belt runs "wobbly" or races back and forth across the pulleys, it is not giving its best service nor can it have a long life. Power is lost and production limited.

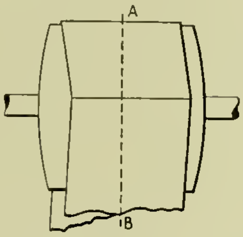


Fig. 1—A Belt Which Will Not Run True

Belt ends should always be cut to a line carefully laid out with a square. If a square is not used, one or both ends of the belt will be cut unevenly or irregularly, which prevents smooth running. Even the use of a straight edge does not assure the results obtained by using a square, for the slip of a fraction of an inch will bring the belt ends together at an angle, as shown in Fig. 1. As the belt moves from side to side, the line of direct pull, *A-B*, moves from one side of the belt to the other, imposing shifting and irregular strains, which no belt can stand indefinitely.

There is only one way to obtain correct results, which is to use a belt square and to keep it in place until the belt is cut all the way through. Cutting to the square assures an even cut all the way through the belt and all the way across. Then the belt ends can be brought together in a tight, but evenly running, flush joint. For belts up to 15 or 18 in. wide, the ordinary square can be used, pressed firmly against the edge of the belt with the knife held vertically. The knife should be sharp with the point wet occasionally in order to cut more easily. When a number of belts have to be cut, a good method is to drive two nails in a large block of wood, and against these set the edge of the belt and the edge of the square. This prevents either the belt or the square slipping.

Wide belts are more difficult to square correctly, and the difficulty is often increased by slight variations in width, which throws the square out. To avoid this and assure perfect results, the method illustrated in Fig. 2 has proved valuable. At any point near where the belt is to be cut, measure across and find the center, as at *A-A*. At any distance back of this, say, 2 or 3 ft., find the center again, as at *B-B*. Between the two center points draw a clean, sharp line, marking the center axis of the belt. Using the square against the center line, trim off the end of the belt, holding the square firmly in position. Two small nails driven in the center line will keep the square from slipping.

For cutting the other end of the belt, find the center line, as just described. At any point on this line other than where the belt clamps will come, take a point *C*, as in Fig. 2, and, using the square as illustrated, draw a line *D-C-B* at right angles to the axis, and all the way across from edge to edge. It is sometimes easier to draw this line by marking the points *D* and *B* and then placing a straight edge through the points *D-C-B* to draw the line. This line *D-C-B* will constitute a "base line" to measure from after the belt is in the clamps. Do not cut on this line.

The exact position where the belt is to be cut can be determined after the clamps have been put on and the belt brought into position. Measure forward from the line *D-B* an equal distance on each side of the belt to the cutting point, using calipers to measure over the belt clamp or running the ruler through the edges of the clamp. As a matter of convenience, always cut one end of the belt square and get it ready for making the joint before putting the belt into the clamp.

Remember that when doing a job, it is much easier to do it right than to do it over. This applies to making the completed joint as well as to cutting the belt. Therefore, it is best when joining a belt to do so in a way which is permanent and which assures the belt's most satisfactory service.

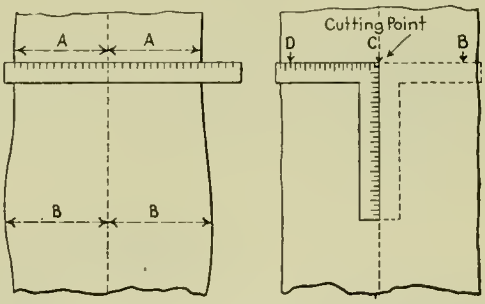


Fig. 2—Method of Squaring Uneven Belt

The writer has had considerable experience working with belting manufacturers in solving the problems of efficient belt joining, and is much opposed to methods which require punched holes in the belt or which in any way cut or weaken the lengthwise, power-carrying fibres of the belt. No belt can give better service than its method of joining will permit, and if wasteful or destructive means are employed, the strength of the belt is lessened, its service impaired and its life shortened. Laced belts are frequently found in which from 40 per cent to 70 per cent of the cross section of the belt is removed in punched holes. Such a belt joint cannot be expected to give the full service of the belt.

The ideal belt joint is one which would run the same as endless without the drawbacks of difficulty in making and later shortening to take up stretch. Belting manufacturers themselves estimate that only a small percentage of belts need to be made actually endless. Their estimates range from ½ of one per cent to two per cent. It is possible to make belt joints which run the same as an endless belt and which meet practically all requirements of the belting field, without having any of the objections noted above.

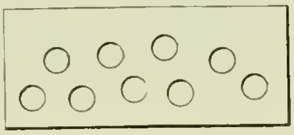


Fig. 3—Aggregate Amount Punched Out is 75 Per Cent of Total Cross Section

The accompanying list shows the qualifications of a belt joint, by which any engineer can check up the comparative efficiency of his own methods:

The Efficient Belt Joint

1—Will maintain the maximum strength of the belt.
2—Will avoid destruction or weakening of the lengthwise power-carrying belt fibres.
3—Should prevent breaking the belt back of the joint.
4—Must not hammer on the pulleys.
5—Must not be subject to wear or crystalization.
6—Will insure continuous, uninterrupted operation without supervision.
7—Hugs the pulleys tightly and assures full transmission of power.
8—Runs silently, the same as an endless belt.
9—Can be easily taken apart for removing or shortening the belt.
10—Is safe against accidents or breakdowns.
11—Must be easily and quickly made without special equipment.
12—Will last for the life of the belt.

The leading manufacturers of belt fasteners are always willing to give engineers full data regarding their products, and a check of the different methods against the qualifications above should enable any engineer to determine for himself which is going to assure getting the most satisfactory results and service from belting.

Limitations of Thermit Welding for Repairing Cast Iron

In a recent issue of Reactions the following explanation regarding the conditions governing the welding of cast iron by means of thermit is given:

In thermit welding, the superheated steel produced by the reaction, when tapped into the mold surrounding the weld, naturally fuses back into the fractured parts two or three inches on either side and the whole mass solidifying at one time effects the repair. The excess metal of the weld may then be removed or not as the necessity indicates.

In cast iron welding, steel is the welding medium and the weld material will, therefore, necessarily consist of a mixture of this steel and the cast iron of the parts being welded. The graphitic carbon in the cast iron, therefore, combines with the thermit steel, thus making a high carbon steel which usually can be machined only by grinding. This material, however, is not so brittle as cast iron and is physically stronger.

In the second place, in considering thermit repairs of cast iron, it should be borne in mind that the weld material is steel and, therefore, has double the shrinkage of the cast iron. This difference in shrinkage is of no importance where the section being welded is approximately square or equiaxed. However, where the length of the section at the fracture is four or five times its thickness, this difference in shrinkage is evidenced by one or more minute cracks perpendicular to the line of the weld and extending through the weld material only. These cracks are naturally caused by the difference in shrinkage, the cast iron parts tending to restrict the shrinkage of the thermit steel along the length of the piece. Such hairline cracks will be found in the welding of sections such as, for instance, 12 in. by 24 in., but would not be found in sections 12 in. by 12 in. The cracks are unimportant, as they are parallel to the line of strain.

Experience proves conclusively that where the length of a fracture is not more than four or five times its thickness and where the subsequent machining can be accomplished by grinding, a thermit weld can be made with entire success.

The Equalization of Spring Rigging

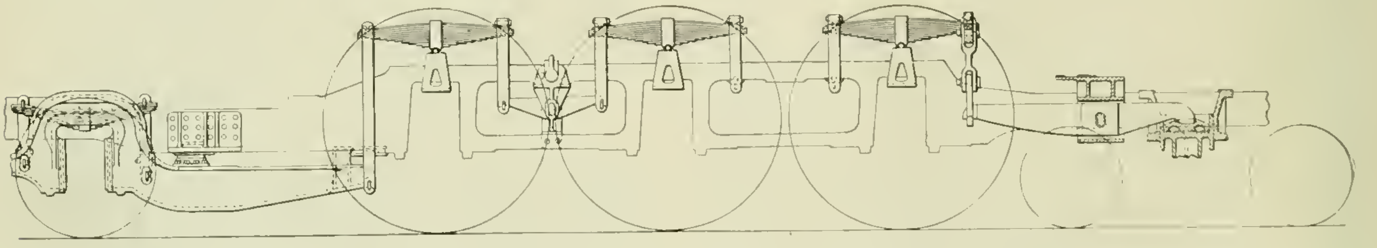
BY J. McALLISTER

General Foreman, West Albany Shops, New York Central

Because the springs and spring rigging used on a locomotive cannot be classed as motion work, there is a strong tendency to underestimate its importance and become careless in making necessary repairs and maintaining the dimensions called for by the blue prints. The improper equalization of springs and spring rigging has very serious effects, the most important of which, perhaps, is the resultant incorrect distribution of weight. This causes excessive pressure on certain bearings, which means that they will run hot and require new brasses frequently.

Hot bearings necessitate frequent repacking and oiling of boxes, wasting a large amount of oil. They also cause many engine failures and many stops to cool the boxes and repack the cellars. In more serious cases where the cutting action has gone on too long, new brasses must be applied to the driving boxes and the cut journals turned. In addition, hot bearings tend to make indifferent engine and train crews on account of the extra disagreeable work necessitated by cooling and repacking the boxes.

Improper spring equalization is caused by poor methods of repairing and assembling spring rigging. It is the usual practice to repair spring hangers to standard sizes. When a locomotive is being broken in, it is usually found too low and must be returned to the shop to be raised. This operation is performed by jacking up the locomotive, shortening a hanger here and there, putting a liner in the center casting, etc. This, of course, results in all idea of equalization being lost and puts excessive weight on one or more of the bear-



Elevation Showing Arrangement of Spring Rigging On Pacific Type Locomotive ings, causing them to run hot, which brings about the evils previously enumerated.

The very best engineering talent is employed in designing locomotives and it should be the aim when repairing them to perpetuate the designer's idea of the locomotive as a whole. To do this it is necessary to equalize springs by shortening the hangers to correspond with tire wear, for example:

The original thickness of the tire is 3½ in. and all parts of the spring rigging are made to blue print sizes. If the locomotive is shopped and the tires turned to 3 in. all spring hangers should be sent to the blacksmith shop and shortened ½ in. A ½-in. liner in the engine truck center casting and a ½-in. liner under the trailing springs will bring the locomotive to its original level.

It is well for the gang foreman to examine and measure the thickness of crown brasses before putting wheels under a locomotive. If one brass is found ⅛ in., for example, thinner than the other, a suitable liner should be placed under the spring saddle of that box. When spring rigging repairs are handled in this way, the designer's idea of equalization is maintained and hot bearings, with their attendant evils, are reduced to a minimum.

Standard Valve Motion Pins and Bushings

A Method of Standardizing, Manufacturing and Fitting Pins and Bushings in Locomotive Valve Gears

BY M. H. WILLIAMS

In certain central production shops of the larger railways, valve motion pins and bushings required for locomotive valve gear repairs are blanked out and finished to predetermined grade sizes. Surfaces, like the straight part of the pin and the bore of the bushing, are finished complete at the time of manufacture and do not require additional machining when being fitted to the levers. The taper ends of pins and the outer surfaces of bushings are made sufficiently large to admit of machining to such sizes as may be necessary to fit worn levers.

Important results have been made possible by a careful study of the requirements and standardization of the bearing surfaces in reference to each other so that they are interchangeable. For cases where the lever holes are greatly worn, the running fits also are standardized to grade sizes. That is, if the original size of the running fit of these pins and bushings is 1½ in., grade sizes are made 1 9/16 in., 1⅝ in., etc., or such sizes as may be necessary.

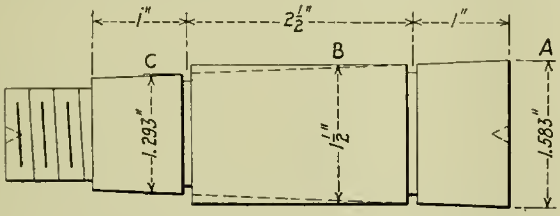


Fig. 1—Standard Pin With Taper of 1-In. per Foot

Standardization of Parts

On account of the many sizes of holes resulting from frequent reaming of the lever clevises, it is not generally considered desirable to make the taper ends of pins to finished sizes, but rather to blank them out, leaving sufficient metal for fitting at the time of application. In some cases the taper ends also are finished to grade sizes and both of these methods will be explained later.

With most designs of pins, especially where the taper is more than ¾ in. per foot, it is possible to increase the diameter of the taper ends somewhat more than called for on the locomotive drawings without encroaching on the straight surfaces. Where the rod clevises are greatly worn, however, it becomes necessary to enlarge the bearing surface and the bore size of the companion bushing which is done to grade sizes.

Grade sizes are determined in the following manner for the pin illustrated in Fig. 1. The ends have a taper of 1 in. per foot, the bearing surface *B*, being 1½ in. in diameter by 2½ in. long. The two ends are each 1 in. long. The size of the large end at *A* is shown as small as it may be made: 1.583 in. The diameter of the opposite end at *C* must correspondingly be 1.293 in. which agrees with the 1 in. per foot taper as shown by dotted lines. A pin made to these dimensions can be used in a bushing having a 1½ in. bore and admit of finishing the full length of the taper surfaces. If the tapers are smaller, the beginning of the large taper will be smaller than the bearing surface.

A pin of the greatest extreme of taper end sizes with the same bearing surface *B* is shown in Fig. 2. The small taper at *C* equals the 1½ in. bearing size. The head is shown enlarged to 1.790 in., which is the largest that may be used with a 1½ in. bushing. It is evident that to go to a larger taper end will result in not having a full taper end at *C*. Figs. 1 and 2 show the smallest and largest taper ends that can be used with a taper of 1 in. per foot in a 1½ in. bushing, 2½ in. long. The diameters of the taper ends and the grade sizes are calculated as follows: The taper per inch is obtained by dividing the taper per foot by 12 and is 0.083 in. This figure multiplied by the length gives the variation for any length or section of the pin. Likewise the taper per inch multiplied by the length of the bearing surface *B* will indicate the greatest difference in diameter possible between grade sizes. In Fig. 1, the diameter at *A* is the bearing size of 1½ in. plus the taper for 1 in. length, or 1½ in. + 0.083 in. = 1.583 in. In Fig. 2, the diameter at *A* is the taper calculated from the 1½ in. diameter at *C* which is 3½ × 0.083 in. + 1.500 in. = 1.790 in. These calculations are necessary in order to settle on the largest diameters to which the head end at *B* should be blanked out.

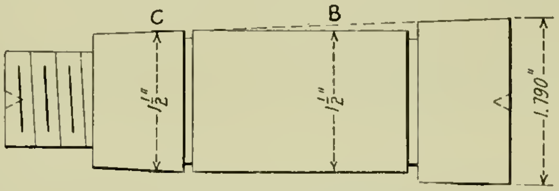


Fig. 2—Standard Pin With Greatest Extreme of Taper End Sizes

The maximum increase of grade sizes for pins having a bearing surface 2½ in. long will be 2½ × 0.083 in. = 0.207

in. It is evident that the second grade size of *B* can be 1.707 in.; the third 1.914 in., etc. From simple calculations of this nature grade sizes for any size and taper may be quickly calculated.

As a general proposition, the grade sizes of bearing surfaces *B* are calculated and tabulated or card indexed for all pins frequently used. One large shop advances the grade sizes by 1/16 in., that is, the pin bearing surfaces are made standard, 1/16 in. and ⅛ in. larger than standard which works out in a very satisfactory manner. The objection to too large an advance in grade sizes is the enlargement of the bushing bore which results in a thinner wall of that member.

Having determined the grade sizes, it is next necessary to set tolerances for bearing surfaces and the bore of bushings. There should be between 0.004 in. and 0.006 in. play between the pin and bushing when the two are in place, in order to allow for a running fit and flow of the oil. When pressing the bushing into the lever, the bore will be reduced about 0.002 in. to 0.004 in. depending on the thickness of the wall and the care with which the fit is made. Therefore, the bushing bore should be made about 0.008 in. larger than the pin.

When manufacturing, the taper ends are preferably blanked out as shown in Fig. 2 with the larger end of the smaller taper shown at *C*, equal in diameter to bearing surface *B*, the large end being the taper extended from *C* as determined by calculation and shown by dotted lines. From a manufacturing standpoint, it is an advantage where the sizes are standardized as the number of sizes will be reduced, consequently, the number of one size called for at one time will be increased to the point where they can profitably be made on automatic screw machines or turret lathes.

Blanking Out and Finishing Pins

No attempt will be made to explain, except in a general way, the machine operations employed when blanking out pins and bushings. They are generally made from hot rolled low carbon or screw machine stock, or some soft steel that is free turning and free threading. When manufacturing, the taper ends are rough machined to the approximate size, the threaded portion made to correct size and the holes for lathe centers drilled in the ends. In some cases a groove is made at each end of the bearing surface next to the tapers for clearance when grinding as shown in Figs. 1 and 2. The bearing surface that should be close to gage is machined about 0.020 in. large to admit of final finishing, as will be explained later. The threads are cut on a bolt threader, or in some cases this threading is done when blanking out. Holes for cotter keys or taper pins and spline keys are drilled with a drilling jig. The pins are in some cases used in a soft state with brass bushings. Where this is the practice, they are ground on the bearing surface *B* to the exact micrometer or gage sizes for which a limit is set that should not be more than 0.001 in. above or below the nominal size.

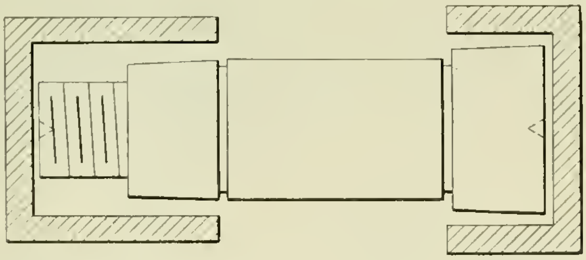


Fig. 3—Method of Protecting Ends When Case Hardening

Where pins are to be casehardened, it has been found good practice after blanking out to grind the bearing surface *B* previous to hardening about 0.010 in. larger than the final size required. This is done in order to true up this surface and correct errors resulting from the lathe centers not being true and to remove roughness left when blanking out.

The pins are now ready for casehardening, an operation governed by the machines available in shops where the pins are to be finally fitted to the levers. If grinding machines have been installed, the pins are casehardened all over except the threaded portion which is protected by covering with fire clay. If grinding machines have not been installed, one of two plans mentioned below is followed. First, the pins are carburized only. That is, the threaded end is protected as explained above, placed in the casehardening box and heated in the usual manner. When removed from the furnace the box and contents are allowed to cool and anneal. This results in a soft high carbon surface that may be machined when fitting to levers similar to annealed tool steel and may be turned as desired. Second, the threaded ends and also both taper ends may be covered with fire clay held in place by cast iron cups or gas pipe as shown in Fig. 3. Pins, cups and fire clay are then placed in the casehardening box, heated and quenched in the usual manner. This results in hard bearing surfaces and soft taper ends, and as a result the ends may be turned when fitting to the levers.

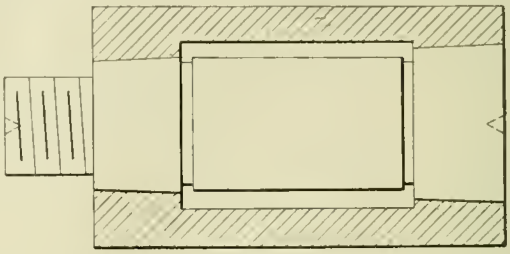


Fig. 4—Female Gage for Taper Ends

The bearing surfaces of pins that have been casehardened or carburized only are then returned to the central shop and ground on the bearing surface to exact gage sizes as explained in connection with soft pins. In some cases, this practice is modified by grinding the taper ends to grade sizes that may vary by 1/64 in., 1/32 in., etc., the ends being carefully fitted to taper female gages as shown in Fig. 4. After completion by either of these methods, the pins are placed in stock.

Blanking Out Bushings and Fitting to Rods

Bushings are made from the same material as the pins, in automatic screw machines, the holes being drilled and reamed about 0.010 in. small to allow for final grinding. The outside is rough machined to such sizes as may have been set when standardizing these parts. The oil holes are drilled and the oil ways milled, after which they are casehardened or carburized by one of the methods that have been explained for hardening pins. The bore is ground to plug gage sizes that should not vary more than 0.001 in. from set sizes. The diameter of bore at this grinding is made 0.008 in. larger than the pin bearing size. If grinding machines are not available for machining the outside of the bushings, they are carburized as explained in connection with pins, the bore being ground to gage size and placed in stock.

A flat gage, as shown in Fig. 5, has proved very useful for checking the accuracy of the taper reaming of clevises and also for measuring the diameter of holes at any point. The gage is made of hardened steel about ¼ in. thick, the edges fitting the taper holes being ground on centers similar to the practice when grinding cylindrical gages. One side of the gage is graduated, each line marked with figures indicating the exact diameter at that point.

Pins and bushings made as above explained in the central production shop are finished on the bearing surfaces and the final work is confined to machining the taper ends of pins and the outsides of bushings. When measuring the diameter of clevis taper holes, the graduation nearest the inside of the smaller jaw is usually read. This point is chosen because it is desirable that the shoulder on a taper pin shall stand away a small amount from the clevis to allow for drawing up when wear takes place. Also in the event of the width of clevises not being correct, the error will not affect the fitting of the pin at this point. Should the hole be irregular, the gage will show the error, in which event, the lever is reamed just enough to true up or to reduce to gage sizes according to the method used when fitting the pins.

Grinding Taper Ends

By the use of suitable cylindrical grinding machines, the taper ends of pins are ground to fit the different sized holes found in repaired levers in from 10 to 15 minutes. The pins while being ground are driven from the threaded end, a method which admits of finishing both ends without reversing the pin in the machine. The machine table is set to the correct taper after one or more trials, and when once set, any number of pins of the same taper may be ground without resetting.

The exact diameter in thousandths required is read from the taper gage as shown in Fig. 5. In order that the pin shall fit properly, the diameter of the taper at that point must be the same as indicated on the gage. When grinding, the pin is measured over the taper as shown at *C*, Fig. 6, with micrometer calipers and finished to a size agreeing with that read on the gage. This measurement is readily made where a groove has been made in the pin as shown.

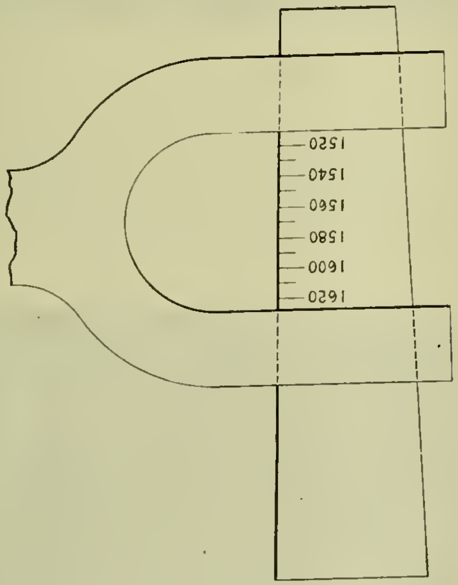


Fig. 5—Flat Gage for Checking Accuracy of Taper Reaming

When the smaller taper has been ground to the proper size, the micrometer-dial or throw-out on the grinding machine governing the in-feed of the grinding wheel is set. The wheel is then transferred to the large taper end and the wheel fed in to the same marking or setting of the throw-out stop used for the small end. This results in the two ends having the same taper and the pin will generally fit the lever at the first trial. Errors may result from the spring of the machine, or the personal equation, but with an operator who has had practice, about 75 per cent of the pins will fit at the first trial. The grinding machine should be one of the larger sizes and have the necessary weight and stiffness in order that the grinding wheel shall not spring away from the work when grinding the two ends.

A grinding wheel as thick as the length of the taper ends is fed directly onto the work and not traversed. Where the wheel is kept true by occasionally passing a diamond over the surface, this method has been found quicker than traversing the wheel.

Where soft pins are machined on lathes, the same general plan is followed. If the pins have had selective case-hardening, they will be completed in this operation and can be placed in service.

Where pins are carburized only, they are fitted in a similar manner and hardened, after which with a slight rubbing up of the bearing surface, they are ready for service.

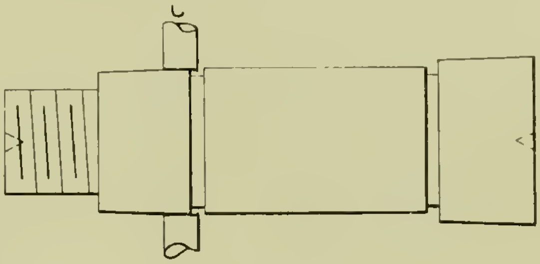


Fig. 6—Position of Micrometer Calipers in Measuring Largest Taper Diameter

In order that the bushings previously ground in the bore shall not be distorted when forced into levers, it is necessary that the lever holes be trued up by grinding on a planetary grinding machine such as that made by the Heald Machine Company or by reaming. The bushings are ground on the outside from 0.004 in. to 0.005 in. larger than lever holes and forced into place. Should it happen that the taper holes in clevises have been enlarged so that the smaller or new size pins and bushings will not answer, the next larger size is used.

Advantages of Grade Sizes

Making pins and bushings as above explained has certain advantages. It permits of manufacturing in larger quantities with the use of the most modern machines and methods at central production shops. On account of concentrating the grinding of bearing surfaces in one shop, this work can be done more economically and accurately. In repair shops, the fact that these parts are finished up to the point of grinding or turning the taper ends of pins and the outside of bushings is a great advantage. Also the fact that any pin will fit any bushing of the same class often makes it possible to change levers from one locomotive to another without fitting, a condition which is hard to attain unless these parts have been standardized.

Cost of Tool Breakage.—Convincing evidence of the high cost of tool breakage is afforded by the records of a Portland, Ore., factory. According to the Iron Age: "The records are a convincing testimony to the expense of putting good tools in the hands of careless or incompetent workmen. A charting of tool breakage shows that it is particularly heavy when numbers of new men are put to work. Damage to tools is a big problem, and careless men can destroy in a short time tools far in excess of their labors for weeks and months. But greater than the loss in money is the fact that it is in some cases almost impossible to replace at once many special high speed tools that are destroyed. Breakage of several important implements at about the same time compelled the plant to lay off a machine and hold up the entire progress of production."

The Management of a Locomotive Repair Shop*

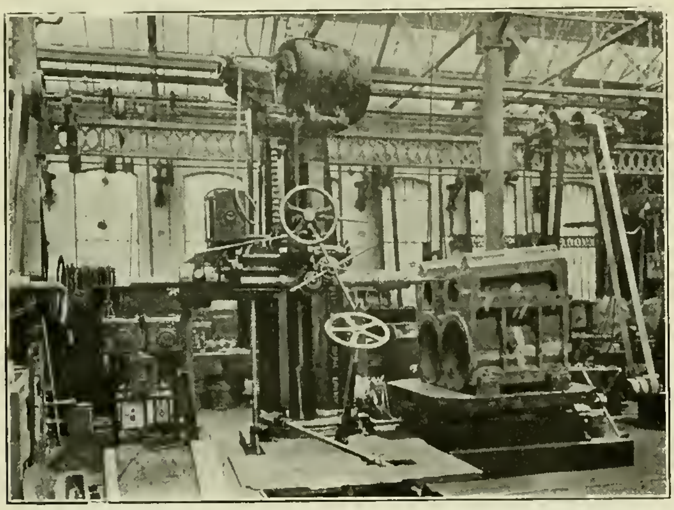
English Railway Practices; Modern Tools and Cost Records Necessary; The Repair Shop's Customer

BY COLONEL H. E. O'BRIEN, D. S. O.
Deputy Chief Mechanical Engineer, Lancashire & Yorkshire, Horwich, England

THE main objective of the management of a railway locomotive workship is essentially different from that of a commercial manufacturing works; the engineering management of a commercial engineering works desire to see a constant expansion of their shops, while in the case of a railway management their desire should be to see a constant shrinkage of the shops brought about by:

(1) Improved methods of manufacture.
(2) Improved organization.
(3) Rectification of errors in design and material with the object of reducing renewals and repairs to a minimum.

It is possible to effect this because the capital expansion of the locomotive stock is very slow on English railways, and therefore the capacity of the works should more than keep pace with the demands if the management is progressive, in spite of the increased weight and power of the more modern stock. The number of locomotives on the Lancashire & Yorkshire has only increased from 1,326 to 1,645 in the last 20 years.



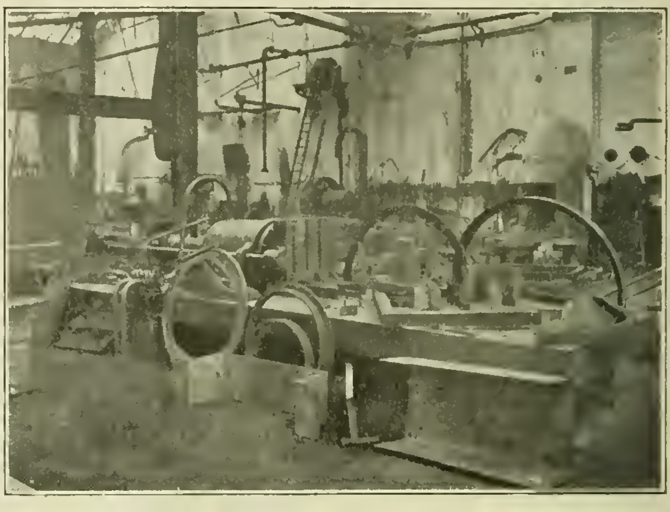
Asquith Horizontal Drilling, Milling and Tapping Machine Used With Eminent Success on Cylinders in the Horwich Shops

Modern Tools Should Be Installed on a Commercial Basis

While patient attention to methods of manufacture on existing machines will result in increased output, the best results will not be attained unless the most modern and most highly productive and specialized machinery is, on a commercial basis, applied to the work as rapidly as the machine tool manufacturers make it available.

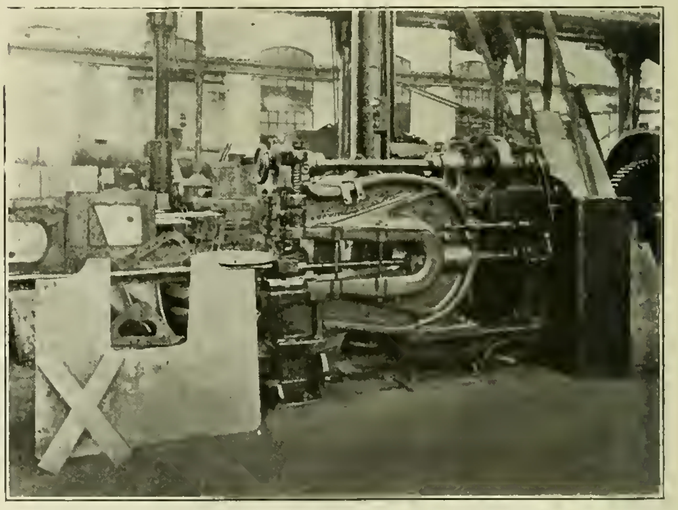
A machinery renewal fund should exist in every works based on a ten years' life of the machinery in order to allow for both wear and tear and obsolescence. The introduction of high speed steel between 1903 and 1910 put many machines simultaneously on the scrap heap; higher speed steels and compound cutting metals such as "Stellite" are in sight, and funds should be available in every shop to enable the fullest advantage to be taken of such improvements.

The author does not advocate the wholesale purchase of new and more powerful machines purely on an arbitrary basis. The method of procedure must be based on a knowledge of the existing annual output of each article dealt with. These records are easily obtainable from the time sheets.



A Bending Press for All Kinds of Work That Has Given Splendid Results

To illustrate this procedure more fully an example is given in connection with drilling operations. These jobs carried out on three old machines have been tabulated with existing prices or costs; new piecework prices have been worked out for these articles by the rate fixer on the basis attainable with the new machine (in most cases it is good policy to send samples to the machine tool maker and obtain guaranteed times), a balance sheet is then prepared as illustrated in Fig. 1, showing the return obtainable on the capital expenditure. After all necessary allowances have been made the return should be such as to enable the machine to make its own contribution to the renewal and obsolescence fund, or in other words, it is



Gray's Sheet Metal Cutting Machine

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* An abstract of a paper presented to the Institution of Locomotive Engineers, England.

hardly justifiable to purchase a new machine unless a return of approximately 8 per cent on the capital expenditure is obtainable.

There is another broader and more approximate way of looking at the problem on the basis that where two new machines can be installed to do the work of three existing ones, the gain in floor space and the reduction in labor cost will justify a capital expenditure of £2,000 ($10,000), 10 per cent on this sum representing the cost of one machinist's wages per annum. When the purchase of a machine has been decided upon, a profit and loss ledger account is opened in the works manager's department, which shows the work done by the machine and the economy effected over the piecework prices, which would have had to be paid had the old machine been retained. The exact return attained by the purchase of new machines over a period of years is therefore known. The above are both rough and ready methods, open to considerable criticism from an accountant's point of view, but in practice they produce good results.

		Old Conditions.*		New Conditions.*		
Article.	Annual Quantity.	Price. s. d.	Total Cost. £ s. d.	Price Based on these Times s. d.	Total Cost. £ s. d.	Saving. £ s. d.
Mechanical capstan heads	24	6 2¾ dozen	0 12 5½	4 0 dozen	0 8 0	0 4 5½
Hydraulic capstan heads	60	1 3 each	3 15 0	0 10 each	2 10 0	1 5 0
Electric capstan valve	24	1 3 each	1 10 0	0 10 each	1 0 0	0 10 0
Standard 10-ton crane sides	6	23 4 each	7 0 0	15 9 each	4 14 6	2 5 6
Standard 10-ton crane roller box	6	14 10 each	4 9 0	9 11 each	2 19 6	1 9 6
Standard 5-ton crane sides	6	20 2¾ each	6 1 4½	13 6 each	4 1 0	2 0 4½
Standard 5-ton crane roller box	6	14 10 each	4 9 0	9 11 each	2 19 6	1 9 6
Crank ingots (drilling through for parting in two)	30	13 3¾ each	19 19 4½	8 10 each	13 5 0	6 14 4½
Crank slabs for solid slabs,	30	14 5¾ each	21 14 4½	9 6 each	14 5 0	7 9 4½
Cylinders for stuffing box 8 cwt. hammer	12	8 6¼ each	5 2 3	5 8 each	3 8 0	1 14 3
Grids and frames for gulleys	72	6 2¾ dozen	1 17 4½	4 0 dozen	1 4 0	0 13 4½
Piston rod for 8 cwt. steam hammer	10	10 10¾ each	5 8 11½	7 2 each	3 11 8	1 17 3½
Hydrant standard valve box cover	18	6 2¾ dozen	0 9 4¼	4 0 dozen	0 6 0	0 3 4¼
150 horsepower motor solid axle frames	10	2 3½ each	1 2 11	1 5 each	0 14 2	0 8 9
150 horsepower motor carcase	12	20 2¾ each	12 2 9	13 4 each	8 0 0	4 2 9
200 horsepower motor carcase (solid, drilled complete)	30	37 5½ each	56 3 9	24 10 each	37 5 0	18 18 9
Parachute inlet valves	24	5 5½ dozen	0 10 11	3 6 dozen	0 7 0	0 3 11
Shear blades for high level shears	36	1 6½ each	2 15 6	1 1 each	1 19 0	0 16 6
Water column parachute base plate	6	10 10¾ each	3 5 4½	7 2 each	2 3 0	1 2 4½
Water column standard parachute base plate pipe	18	7 0 dozen	0 10 6	4 8 dozen	0 7 0	0 3 6
Water trough, C. I. (all sizes)	12	2 8¾ each	1 12 9	1 10 each	1 2 0	0 10 9
Bands and gudgeons for gates	12 sets	9 4 set	5 12 0	6 2 set	3 14 0	1 18 0
Flanges, C. I	36	9 4 dozen	1 8 0	6 2 dozen	0 18 6	0 9 6
Lamp bodies	72	3 1¼ dozen	0 18 7½	2 0 dozen	0 12 0	0 6 7½
Lamp belts	72	1 11¼ dozen	0 11 7½	1 4 dozen	0 8 0	0 3 7½
Lamp knobs	72	1 6½ dozen	0 9 3	1 0 dozen	0 6 0	0 3 3
Motor armature spider	12	3 4 each	2 0 0	2 2½ each	1 6 6	0 13 6
Nuts, triangular	864	6 2¾ gross	1 17 4½	4 0 gross	1 4 0	0 13 4½
Platform seat brackets	24	9 4 dozen	0 18 8	6 2 dozen	0 12 4	0 6 4
Shackles for swivel hooks	96	3 1¼ dozen	1 4 10	2 1 dozen	0 16 8	0 8 2
Turntable centre pin	144	1 9¾ each	13 1 0	1 3 each	9 0 9	4 1 0
Tube plate template	1	40 9½ each	2 0 9½	27 2 each	1 7 2	0 13 7½
Jib foot for 5-ton crane	12	4 3¼ each	2 11 3	2 10 each	1 14 0	0 17 3
Crossbar for 5-ton crane	12	5 7 each	3 7 0	3 8 each	2 4 0	1 3 0
Hydraulic crane jib, 2 uprights and 1 centre	4	24 7½ each	4 18 6	16 4 each	3 5 6	1 13 0
Hydraulic crane cylinder	8	8 6¼ each	3 8 2	5 6 each	2 4 0	1 4 2
Foundation plate for electric capstan	4	5 5¼ each	1 1 9	3 7 each	0 14 4	0 7 5
Candlesticks for electric capstan	12	10 10¾ dozen	0 10 10¾	7 2 dozen	0 7 2	0 3 8¾
Worm wheel box for electric capstan	4	1 3½ each	0 5 2	0 10 each	0 3 4	0 1 10
Coal box bottoms	12	6 2¾ dozen	0 6 2¾	4 3 dozen	0 4 3	0 1 11¾
Coal box levers	12	7 9 dozen	0 7 9	5 10 dozen	0 5 10	0 1 11
Crank shaft for hydraulic capstan	24	2 1¾ each	2 11 6	1 6 each	1 16 0	0 15 6
Cylinders for hydraulic capstan	12	5 5½ each	3 5 6	3 9 each	2 5 0	1 0 6
Foundation plate for hydraulic capstan	12	5 5¼ each	3 5 3	3 8 each	2 4 0	1 1 3
Bushes for large shaft	12 prs.	4 11¼ pair	2 19 3	3 4 pair	2 0 0	0 19 3
Other miscellaneous work	..	....	136 12 0	....	97 13 1	38 18 11
War wage, 21/6 + 7½% on total earnings	..	....	200 1 3	....	133 16 10	66 4 5
			£556 6 7¼	....	£377 11 10	£178 14 9¼

Or 32.12 per cent Saving on Old Prices.

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* Old conditions: 3 drillers, 3 machines. New conditions: 2 drillers, 1 machine.

PARTICULARS OF MACHINES DISPLACED.

	£ s. d.
R. 16, 6 ft. 6 in. Radial Drilling Machine, ex Messrs. Muir & Co.	188 0 0
R. 18, 6 ft. 6 in. Radial Drilling Machine, ex Messrs. Muir & Co.	188 0 0
R. 22, 8 ft. Radial Drilling Machine, ex Messrs. Craven Bros	190 0 0
	£566 0 0

	£ s. d.
Cost of new machine	1,069 15 0
Cost of mains	30 0 0
Cost of motor (10 h.h.p.), Horwich make	80 0 0
Cost of starter and switch gear	23 8 0
Cost of taking out old machines and fixing new one	15 0 0
	1,218 3 0
Less credit for old machines	130 0 0
	£1,088 3 0

	Wages as per other side £ s. d.	Repairs at 5% per annum £ s. d	Depreciation at 5% per annum £ s. d.	Total. £ s. d.
Old conditions	556 6 7¼	28 6 0	28 6 0	612 18 7¼
New conditions	377 11 10	54 8 0	54 8 0	486 7 10
	178 14 9¼	26 2 0	26 2 0	126 10 9¼

Or, 11.62 per cent Profit on Investment.

Machine Ordered, August 14, 1919.

Machine received..........................

Account passed..........................

Fig. 1—Balance Sheet for One New 6-ft. Radial Drilling Machine to Replace Three Old Drills

Factors in Economical Shop Production

Modern high speed machines must be filled with work to their full capacity if an adequate return is to be obtained from them; this requirement involves either a large stock of locomotives very fully standardized or the manufacture of parts for stock, or a combination of both these requirements. Intelligent manufacture for stock involves a knowledge of the maximum and minimum weekly or monthly demands for each article, which in turn demands the issue of all machined or manufactured parts, whether new or repaired through the books of a finished work store.

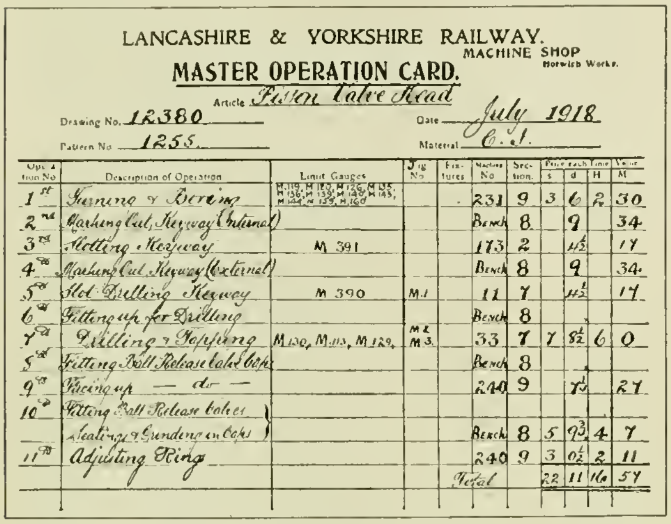
Other salient points requiring the closest possible attention are:—

(1) The reduction of unnecessary work to a minimum; this can be effected by—

(*a*) Inspection of all parts of the locomotive after stripping and cleaning for both flaws and wear; this procedure confines the functions of the machine shop to their legitimate sphere of effecting repairs on definite lines laid down by the management.

(*b*) Elimination of all unnecessary machining operations; this can only be satisfactorily effected by the use of operation sheets, samples of which are shown in Figs. 2 and 3 Close scrutinizing of machining operations by a competent staff of young foremen with modern ideas will often result in a surprisingly large elimination of unnecessary operations.

(*c*) Elimination of fitting operations by the use of limit gages, jigs, machining particularly by grinding instead of scraping, filing, and chipping, *e. g.*, no scraping should be done on any surface which can be reached by a grinding machine; every use of the chisel or file should be regarded as an adverse criticism of the quality of the machine work or the system of standardization, or the design.



LANCASHIRE & YORKSHIRE RAILWAY.
MACHINE SHOP
Horwich Works.
MASTER OPERATION CARD.

Article Piston Valve Head
Drawing No. 12380
Date July 1918
Pattern No 1255.
Material C. I.

Operation No	Description of Operation	Limit Gauges	Jig No	Fixtures	Machine No	Section	Price each Time Value			
							s	d	H	M
1st	Turning & Boring	M.119, M.120, M.126, M.135, M.136, M.139, M.140, M.145, M.144, M.159, M.160			231	9	3	6	2	30
2nd	Marking Out, Keyway (Internal)				Bench	8		9		34
3rd	Slotting Keyway	M 391			173	2		1½		17
4th	Marking Out Keyway (External)				Bench	8		9		34
5th	Slot Drilling Keyway	M 390	M.1		11	7		1½		17
6th	Fitting up for Drilling				Bench	8				
7th	Drilling & Tapping	M130, M113, M129.	M2 M3.		33	7	7	8½	6	0
8th	Fitting Ball Release Valve Caps				Bench	8				
9th	Facing up — do —				240	9		7½		27
10th	Fitting Ball Release Valves Seating & Grinding in Caps				Bench	8	5	9¾	4	7
11th	Adjusting Ring				240	9	3	0½	2	11
					Total		22	11	16	57

Fig. 2—Time and Cost Involved in Finishing a Piston Valve Head in July, 1918 (See Also Fig. 3.)

(2) The reduction of unnecessary transportation of material by—

(*a*) Such methods as the arrangement of all white metalling and coppersmiths' work in the closest vicinity to the erecting shop; suitable location of the cleaning beshes and labor-saving appliances in connection therewith.

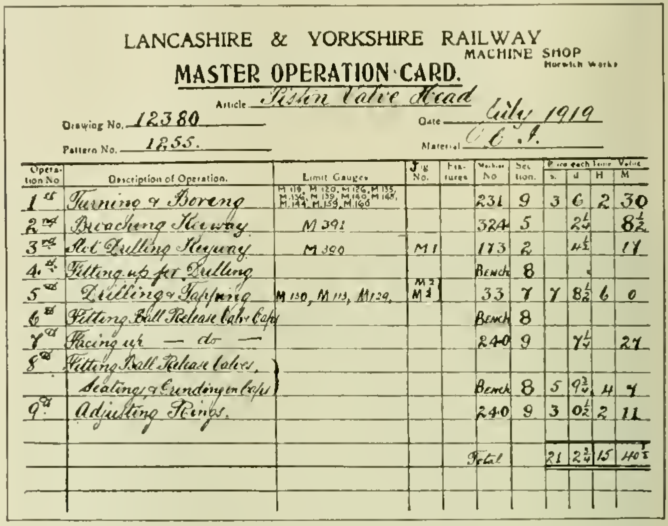
(*b*) Locating benches in the vicinity of the machines principally dealing with the work of those benches.

(*c*) By the retention in the erecting shop of all material proved by inspection not to require repairs.

(3) The closest economy in the use of material to be effected—

(*a*) By specialized inspection for wear, relieving the fitter of the responsibility for deciding when a part is to be renewed.

(*b*) By a continuous watch for fresh points where wear can be reduced by the use of hardened and ground surfaces.



LANCASHIRE & YORKSHIRE RAILWAY
MACHINE SHOP
Horwich Works
MASTER OPERATION·CARD.

Article Piston Valve Head
Drawing No. 12380
Date July 1919
Pattern No. 1255.
Material C. I.

Operation No	Description of Operation.	Limit Gauges	Jig No.	Fixtures	Machine No	Section.	Price each Time Value			
							s.	d	H	M
1st	Turning & Boring	M 119, M 120, M 126, M 135, M 136, M 139, M 140, M 145, M 144, M 159, M 160			231	9	3	6	2	30
2nd	Broaching Keyway	M 391			324	5		2¼		8½
3rd	Slot Drilling Keyway	M 390	M 1		173	2		1½		17
4th	Fitting up for Drilling				Bench	8				
5th	Drilling & Tapping	M 130, M 113, M129.	M2 M3		33	7	7	8½	6	0
6th	Fitting Ball Release Valve Caps				Bench	8				
7th	Facing up — do —				240	9		7¼		27
8th	Fitting Ball Release Valves, Seating & Grinding in Caps				Bench	8	5	9¾	4	7
9th	Adjusting Rings.				240	9	3	0½	2	11
					Total		21	2¼	15	40½

Fig. 3—Improvements Made in Piston Valve Head Job in July, 1919 (Compare With Fig. 3)

(*c*) By the extensive use of graduated sizes of pins and holes and by the use of renewable hardened and ground bushes wherever possible.

(*d*) By the regular inspection of all scrapped material with the object of reconditioning or utilizing for the manufacture of new articles of a smaller size, and directing scrap to the points where it could be best worked up. A scrap inspection shop should be a unit in every large locomotive repair shop, serving the dual purpose of saving material and improving design.

(*e*) By the close analysis of the cause of renewal of any parts of which any appreciable quantity have to be renewed annually.

Half year ending	Total No. of engines in stock	Total No. of engines repaired	Total No. of boilers repaired	No. of boilers repaired —taken out of frames	No. fitted with new firebox	No. fitted with new copper tube plate	No. fitted with new ¾ or ½ copper sides	No. fitted with new copper door plate	No. fitted with new steel door plate	No. of firebox patches	No. of barrel patches	No. of crown plate patches	No. of door plate patches	No. of copper stays renewed	No. fitted with new tubes	No. fitted with pieced tubes	No. of renewal boilers built	No. of renewal boilers fitted
June, 1900	1,343	434	367	31	22	8	...	...	...	...	...	...	...	......	67	79	16	10
December, 1900	1,360	422	394	62	25	3	...	...	...	...	...	...	...	......	81	61	22	24
June, 1901	1,378	356	309	34	33	11	...	...	...	...	...	...	...	......	81	62	13	20
December, 1901	1,397	390	331	76	24	14	1	...	...	...	...	...	...	......	91	76	14	22
June, 1902	1,412	393	358	96	21	32	2	...	...	...	...	...	...	......	124	78	45	29
December, 1902	1,427	451	392	61	10	25	9	...	...	...	...	...	...	......	142	91	56	41
June, 1903	1,432	416	339	56	11	19	1	...	...	...	...	...	...	......	133	60	31	39
December, 1903	1,438	446	376	54	5	33	3	...	...	...	...	...	...	......	140	85	37	44
June, 1904	1,443	373	315	51	8	34	5	...	No Particulars.					......	111	69	39	32
December, 1904	1,448	427	357	39	2	41	15	...	...	...	...	...	...	......	172	61	27	35
June, 1905	1,448	385	332	48	8	24	11	...	...	...	...	...	...	......	172	96	37	42
December, 1905	1,449	405	333	56	3	35	14	...	...	...	...	...	...	......	189	77	41	41
June, 1906	1,463	404	354	47	7	43	3	...	...	...	...	...	...	......	160	57	22	28
December, 1906	1,478	423	368	50	7	37	17	...	...	...	...	...	...	......	181	63	46	35
June, 1907	1,491	451	388	42	4	41	20	...	...	...	...	...	...	......	178	78	33	42
December, 1907	1,511	458	386	58	6	36	16	3	33	17	38	27	105	46,987	170	101	25	28
June, 1908	1,510	430	376	55	11	46	14	4	36	19	29	36	112	45,101	202	79	30	24
December, 1908	1,510	410	358	60	2	30	19	6	23	22	19	27	99	49,646	225	86	43	43
June, 1909	1.511	380	327	67	5	40	18	3	37	12	25	16	73	45,428	137	124	34	33
December, 1909	1,523	413	329	75	8	51	8	4	43	13	17	14	85	48,278	194	121	52	50
June, 1910	1,531	410	347	69	6	46	8	6	26	6	11	17	71	50,672	198	116	61	60
December, 1910	1,527	411	373	69	2	44	1	9	22	6	22	11	79	46,870	173	141	46	59
June, 1911	1,541	406	374	67	...	49	5	5	37	7	7	6	96	33,328	114	204	57	43
December, 1911	1,549	242	196	52	...	37	...	4	16	5	6	7	68	27,169	80	114	25	34
June, 1912	1,554	286	244	76	4	55	3	4	45	4	12	19	49	37,026	94	141	53	44
December, 1912	1.557	350	300	85	2	66	11	4	54	11	6	17	140	45,865	143	161	41	51
June, 1913	1,566	374	290	99	2	89	10	2	66	12	12	7	136	51,853	131	173	44	46
December, 1913	1.577	381	344	112	3	63	10	2	53	21	14	5	155	46,171	142	182	68	58
June, 1914	1,573	3·6	309	91	2	67	5	5	49	12	12	3	90	34,615	154	165	60	63
December, 1914	1,575	326	284	77	...	45	7	2	26	12	10	1	82	28,832	158	119	46	38
June, 1915	1,572	335	263	85	...	73	8	2	51	1	10	...	67	35,840	172	117	52	55
December, 1915	1,573	330	282	89	2	57	11	2	34	6	14	2	128	31,874	151	123	64	56
June, 1916	1,572	335	252	72	...	61	9	2	36	9	14	...	115	30,703	169	114	70	70
December, 1916	1,579	258	221	66	...	48	9	...	24	2	5	...	41	29,797	134	94	44	43
June, 1917	1,585	331	294	82	...	57	6	2	26	13	8	...	65	37,696	163	104	35	36
December, 1917	1,599	319	287	77	...	63	6	2	31	9	4	...	116	33,107	175	93	39	32
June, 1918	1,609	335	285	75	...	56	10	2	29	14	2	...	76	34,723	181	112	25	26
December, 1918	1,621	263	244	58	1	60	7	2	29	10	4	...	75	24,463	133	106	23	23
June, 1919	1,632	265	233	74	...	48	5	4	19	2	...	...	44	23,692	130	99	34	33
December, 1919	1,645	310	292	72	...	44	5	1	14	6	1	...	63	29,030	166	98	47	35
Totals	60,509	14,910	12,803	2,665	246	1,731	312	82	859	251	302	215	2,230	948,676	5,911	4,180	1,597	1,567
Average per half year	1,513	373	320	67	6	43	8	3	34	10	12	9	89	37,947	148	104	40	39

Fig. 4—Table Showing Particulars of Boiler Repairs on L. & Y. Boilers, 20 Years Ending December, 1919

(*f*) By the elimination of the more expensive metals wherever possible.

(*g*) By the judicious use of welding and patching, it being remembered that all patching likely to prove a source of maintenance at sheds should be rigorously avoided.

(*h*) As 80 per cent of the engines stopped for back shop repairs are taken out of service on account of the condition of the boiler, a close watch of the trend of boiler repairs is necessary and a statistical record is kept, as shown in Fig. 4.

Boiler Repairs

The efficiency of the methods of boiler repairs in the shop is checked by the reports of three boiler inspectors on the works manager's staff, specially selected for independence and matureness of judgment in connection with boiler work. These inspectors report quarterly on the condition of the boilers examined. Fig. 4 shows particulars of boiler repairs for 20 years by half yearly periods. A summary of the reports for the last nine years is also given in Fig. 5, from which it will be seen that, in spite of the fact that the ratio of the total number of boilers repaired to the total engines in stock is becoming smaller, the condition of the boilers generally shows a steady improvement.

Particulars	1911	1912	1913	1914	1915	1916	1917	1918	1919
Engine with 12 or more permanent plugs in tubeplate	246	225	120	56	42	32	17	14	6
Firebox side thin....	80	117	60	40	36	27	19	20	15
Firebox with small stays	6	37	15	13	9	9	18	11	6
Engines stopped for broken stays, etc..	36	46	10	..	4	3	2	6	4
Engines stopped for broken roof links..	9	3	1	3	2	..	2	1	1
Engines with bad tubes	22	31	4	2	10	5	2	1	8
Number of engines examined	1,758	1,745	1,767	1,786	1,821	1,779	1,776	1,730	1,699

Fig. 5—Summary of Boiler Inspectors' Report, 1911 to 1919 Inclusive

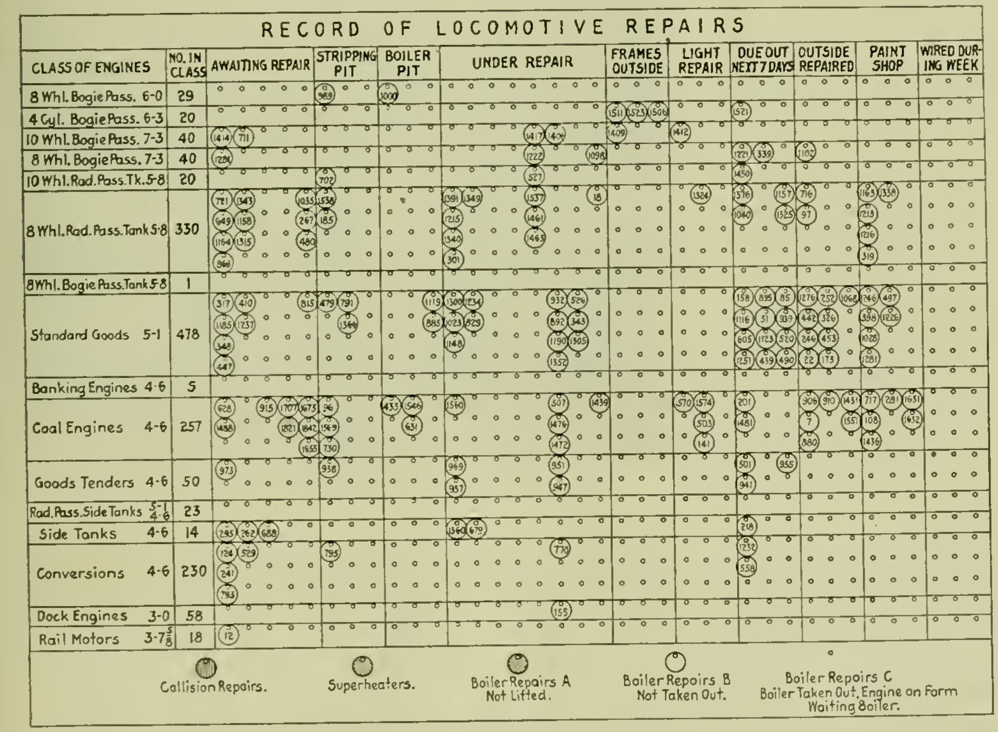


Fig. 6—Repaired Engine Output Board

The erecting shop usually represents about 25 per cent of the total area of a locomotive repair shop; every effort therefore should be directed to reducing the time spent on the erecting shop pits to a minimum.

It is good policy to have a small stock of boilers of each class tubed, mounted, and tested ready to drop into the frames as soon as the frame repairs permit after the old boiler has been lifted out.

To avoid transport of boilers, as much of the boiler repairs as possible should be carried out in the erecting shop. By this is meant such repairs as do not involve machining other than that which can be done by pneumatic or electric portable tools, of which there should be a generous supply; all such tools should be under the special supervision of one man and such an occurrence as an inefficient tool, an air leakage or waiting for a tool should be made an impossibility. The author in his own practice has to a large extent standardized patches which are sent across from the boiler shop shaped and drilled.

Scheduling Repairs

While systematic scheduling of dates on which repair material is to be ready and engines are to be ready for trial is essential, such scheduling is ineffective unless regulated and modified by a daily foremen's conference consisting of the machine, erecting and boiler shops, foundry and smithy foremen as official members, with other foremen called in as required. At Horwich this conference is presided over by the chief works inspector. Supplementing this daily foremen's conference is the work of the progress man attached to each of the principal shops. The progress man's sole duty is to follow up the material required by the charge-hands according to the output boards for repaired engines, and the schedule for new engines. An illustration of the repaired engine output board is shown in Fig. 6.

In dealing with engine repairs the work continually fluctuates, due to defects developing on examination after stripping and to changes in the requirements of the outdoor department; daily changes are therefore necessary in the repair program and the method of conference by the foreman enables immediate decision to be taken to meet the change of circumstance.

Points to Be Remembered

Before describing repair methods the author would like to emphasize a few cardinal points which have, as far as possible, been always kept prominently before the management at Horwich:—

(1) The necessity for keeping the boiler stock young; the L. & Y. have a definite renewal fund which permits of the building of boilers at a rate equivalent to a life of 16 to 17 years.

(2) The desirability of reducing firebox patching to an absolute minimum *vide* the table in Fig. 4.

(3) The importance of the greatest possible use of machinery in order to economize labor.

(4) The adoption of piecework or payment by results throughout the shops coupled with an endeavor to secure the reasonable and intelligent co-operation of labor in obtaining a maximum output.

(5) The infusion of a spirit of broad-minded economy and esprit-de-corps into the supervisory staff.

(6) The most vigorous adhesion to standards; in this connection the author regards the drawing office staff acting in collusion with the outdoor locomotive department,* as tending unconsciously to be the worst offenders against standardization; it is generally far too easy to set a radical change in motion in some small detail which may have far-reaching consequences. No alteration should be permissible in any drawing which has not been considered by a committee representing the shop, drawing and outdoor locomotive departments. Adherence to old standards which are unsuitable in strength or design for the mere sake of standardization is, of course, undesirable.

The only road to progress is that of continual criticism and continual dissatisfaction with the results obtained; the point may be illustrated by the story of the man who said "he had

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*Outdoor locomotive department, as the words indicate, refers to the organization for handling locomotives out on the road and at engine houses.

done his best"; his superior's answer was "that will not do for me; you must try to do better than your best."

Costs

There is no essential need for the management to know the actual cost of every article manufactured or repaired; but it is essential to have accurate costings of groups, *i.e.*, the cost of repairs each year of each class of engine must be known, as must also the cost of each batch of new engines; these costs again should be subdivided into the costs of boilers, smokeboxes, tanks, frames and stays, cylinders, valves, motion, wheels and axles, brake gear, injectors, piping, etc. However, the works manager should be able to call for and obtain within a reasonable time the cost of any article; this is the case on the L. & Y., though the method of sudividing the cost of class repairs into cross headings of groups has not as yet been adopted.

It may not be obvious why extensive costing is not of great value in locomotive repair work, but a little consideration will show that the price of materials is dictated by the outside market, and the piecework prices of labor are fixed, and all reductions of cost must be made by new methods or new machinery or economy in material. Whether these reductions are being made is revealed by the balance sheets and ledger accounts for new machines, by the wages sheets of individual shops, and by the returns of scrap sold or utilized.

The broad costing divisions show tendencies; they indicate, for instance, in the case of tank engines, whether the time is coming when a large number of new tank engines would not be a more profitable investment than repairing the old ones.

In addition to the above costing and statistical checks on the efficiency of the organization, the management must have other figures constantly before them; on the L. & Y. this consists of:

(1) Monthly statements of the weight and cost of materials issued.

(2) Weekly statements of the wages paid, and number of men employed in each shop.

(3) A cross division of the wages paid under the following heads:

- Engine repairs.
- Boiler renewals.
- New engines.
- Renewal of machinery and plant, subdivided under—
  - (*a*) Machinery and plant generally.
  - (*b*) Engines and boilers.
  - (*c*) Hearths and furnaces.
  - (*d*) Cranes.
  - (*e*) Sundries.
- Other workshop expenses, subdivided under—
  - (*a*) Foremen.
  - (*b*) Checking and inspectors.
  - (*c*) Cranemen, tramwaymen, stationary enginemen, etc.
  - (*d*) Laborers.
  - (*e*) Light and power.
  - (*f*) Tools and fittings.
  - (*g*) Pattern-making.
  - (*h*) Sundries.
- Repairs to premises, and various other miscellaneous items.

The cost of castings, forgings, and smithy work is watched by means of balance sheets which are prepared on the same lines as if the smithy, foundry or forge were working as an outside shop supplying the machine, erecting and other shops; therefore so far as the supply of semi-manufactured material is concerned, the works manager is in the position of knowing exactly how he stands in regard to the comparative costs as compared with supplies from outside manufacturers. Owing to the standardization of the product, the actual works cost is necessarily little if any higher than that of a manufacturer, while the manufacturer's general charges, which are bound to be high on account of his necessity for advertising, preparing quotations and estimates, etc., are saved.

Operating Department the Shop's Customer

There is a further test of efficiency and financial solvency. The outdoor locomotive department must be considered as the customers of the shop. No commercial shop can be solvent that has dissatisfied customers. Unfortunately there is and can be no financial test of the commercial solvency of a locomotive repair works, but the satisfaction or otherwise of their customers, the outdoor locomotive department, is probably the best possible test under the circumstances. The policy of the works should therefore be to invite complaints from the outdoor locomotive department, and this is done as far as possible on the L. & Y. by the system of returned waybills and by the trial run of each repaired engine on an easy traffic job, the report of the trial being made by a driver who is independent of the shop staff, and is not hampered or prejudiced by the presence on the engine of any of the men who repaired it.

This does not mean that the outdoor locomotive department should be under any control other than that of the chief mechanical engineer. Any such system means the setting up of co-equal rival authorities in a technical subject within one organization which cannot make for harmony or efficiency.

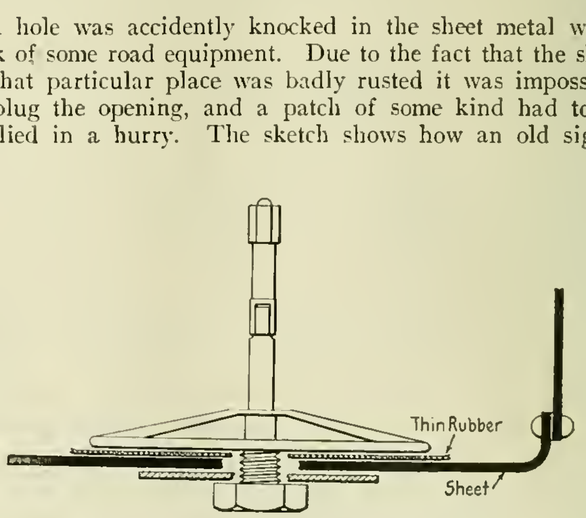
Co-operation the Keynote

The nearest possible approach to the best results in dealing with locomotive repairs is only attainable if the whole of the grades and groups engaged in the work deal with it in a spirit of self-sacrifice, completely sinking their own personal interests for the good of the whole; the general outline of locomotive repair work is so standardized that except in so far as progress on the broad lines indicated earlier in this paper is concerned, there is more engineering of human nature than of material in the work.

Note: *The author included two appendices to the paper describing the routine of engine repairs and the application of limit gages and progressive sizes in the machine shop which will be published in future issues*—Editor.

Emergency Patch Plate Made of Old Air Signal Valve Part

A hole was accidently knocked in the sheet metal water tank of some road equipment. Due to the fact that the sheet in that particular place was badly rusted it was impossible to plug the opening, and a patch of some kind had to be applied in a hurry. The sketch shows how an old signal valve stem and plate was utilized in making a very satisfactory small patch. The sheet did not allow a full nut to be drawn, but to hold the water and stop the opening it served the purpose very well. The idea might be useful under similar circumstances where an emergency application of a patch on thin metal sheet is necessary.



Air Signal Valve Part Used in Patching Sheet Metal Tank

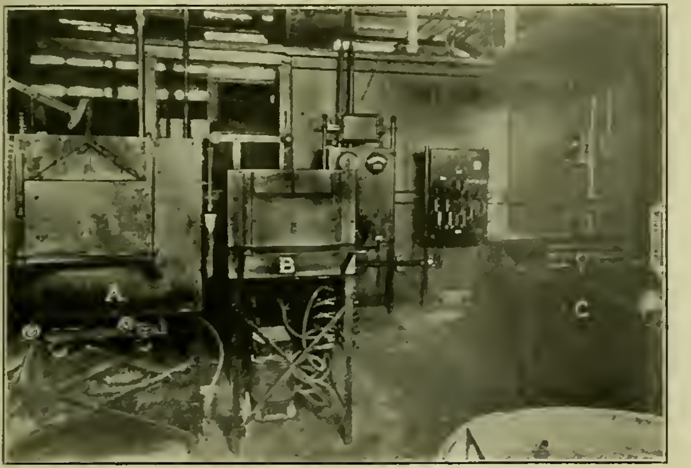
Heat Treating Steel in Railway Shops

Essential Methods and Equipment Needed in the Heat Treatment of Tool Steel for Railway Shops

BY HENRY OTTO
Tool Foreman, Topeka Shops, Atchison, Topeka & Santa Fe

THE controlling factor in all heat treatment is temperature, whether the operation is annealing, hardening or tempering and for any certain steel and particular use thereof, there is a definite temperature point which alone gives the best results. Insufficient temperatures do not produce the results sought. Excessive temperatures, due either to ignorance of what the correct point is or the inability to tell when it exists, will cause "burned" steel. This is a common failing resulting in great loss. Very slight variations from the proper temperature may do irreparable damage.

Due to temperature variation alone, carbon steel may be had in any of three conditions: First, In an annealed state, when not heated to a temperature above 1,350 deg. F.; Second, In a hardened state, by heating to a temperature between 1,350 and 1,500 deg. F.; Third, In a state softer than the second, though harder than the first, when heated to a temperature which exceeds 1,500 deg. F.



Furnaces and Equipment Used in Heat Treating

The hardening of carbon steel is the result of a change of internal structure which takes place in the steel when heated properly to a correct temperature. This change for practical purposes is effective only in those carbon steels in which the proportion of carbon varies from two points to twenty points.

Hardening Steel

The process of hardening steel consists essentially of heating it to the required temperature and quenching it suddenly in some cooling medium. The methods of heating and the different kinds of quenching baths used are numerous. Generally speaking, the furnaces are heated either by gas, oil, electricity, or solid fuel. Each of these methods has its advantages according to the local conditions. Electrical furnaces for hardening and tempering are used in the tool room of the Santa Fe shops at Topeka, Kans.

In the actual heating of a piece of steel several requirements are essential to good hardening: First, Small projections or cutting edges must not be heated more rapidly than is the body of the piece; Second, All parts must be heated to a uniform temperature, as low as will give the required hardness. A higher temperature is uneconomical and dangerous.

Any temperature above the "critical point" of steel tends to open its grain, to make it coarse and to diminish its strength. The temperatures at which internal changes in the structure of a steel take place, are frequently spoken of as the "critical" points. These are different in steels of different carbon contents. The carbon steel used for making reamers, taps, shear blades, etc., at Topeka shops has its decalesence point at 1,385 deg. F. and its recalescence point at 1,280 deg. F. The decalescence point is the proper temperature for hardening and the recalescence point is the proper temperature for annealing.

Furnace Equipment

In the tempering room, there are two electrically heated furnaces made by the Hoskins Manufacturing Company. One of these, known as the Type F. C. furnace, is shown at *A* in the illustration. It has a carbon resister and top carbon plates. The service life of these plates is about 125 hours. The graphite bottom plates and electrodes have a life of about 300 working hours and it is necessary to renew them at regular intervals. The time required for renewing depends entirely upon the condition of the walls or lining. This furnace is used only to bring the tools made of high speed steel to the final heat or from 1,700 deg. F. to 2,300 deg. F. Good results have been obtained with the above furnace on high speed steel tools.

The Type F. B. furnace, shown at *B*, is of the hair pin heat unit type, and is designed for lower temperatures, the maximum being 1,800 deg. F. This furnace is used for carbon steel tools and for preheating all the high speed steel tools in connection with the Type F. C. furnace. The heat units are easily renewed and the cost of maintenance is very low. All carbon steel tools are heated in this furnace for hardening. Both of the above furnaces were installed March, 1917, and have given very good results. They are supplied with alternating current through special transformers.

Oil Tempering Bath

The electrically heated oil tempering bath shown at *C* is made by the General Electric Company, and is used in accurately drawing the temper on carbon steel tools. The oil is heated up to the required temperature and the tool left in the bath until it is heated thoroughly to the temperature of the oil. The tool is removed and after cooling is ready for grinding and use.

Not long ago, it was the practice to send a finished tool to the blacksmith shop for tempering. The blacksmith would guess when the temperature was high enough and quench the tool, afterwards drawing the temper to whatever color he thought was right. The results were always non-uniform and unsatisfactory. With up-to-date electrical equipment, it is a matter of reading the pyrometer and bringing the temperature up to that recommended by the steel company.

High Speed Steel

High speed steel must be heated to a much higher temperature for hardening than carbon steel, a temperature from 1,800 to 2,300 deg. F. being used. The usual method of hardening high speed steel tools, such as lathe, planer, slotter tools, etc., is to heat the cutting end slowly to a temperature of about 1,800 deg. F. and then rapidly to about 2,250 deg. F., or until the end of the tool is at a dazzling white heat and shows signs of melting down. The tool point is then cooled either by plunging it in a bath of oil or by placing the end in a blast of dry air.

The exact treatment varies for different steels and it is advisable to follow the directions given by the steel makers. The following is a table of heat colors when tools are heated without using a pyrometer.

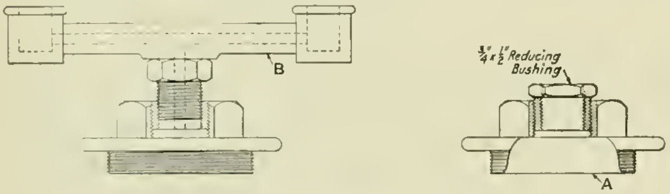
Heat Colors	Degrees Fahrenheit	Heat Colors	Degrees Fahrenheit
White	2,200	Cherry or full red	1,375
Light yellow	1,975	Medium cherry	1,250
Lemon	1,825	Dark cherry	1,175
Orange	1,725	Blood red	1,050
Salmon	1,650	Faint red	900
Bright red	1,550		

In annealing high speed steel an iron box or pipe is used, of sufficient size to allow at least one-half inch of packing between the pieces of steel to be annealed and the sides of the box or pipe. It is not necessary that each piece of steel be kept separate from every other piece, but the steel must be prevented from touching the sides of the annealing pipe or box. It should be packed carefully with powdered charcoal, fine dry lime, or mica and covered with a cap which should be air-tight. The pipe is then heated slowly to a full red heat, about 1,475 or 1,500 deg. F., and held at this heat from two to eight hours, depending on the size of the pieces to be annealed. The parts should be cooled as slowly as possible and not exposed to the air until cold. A good way is to allow the box or pipe to remain in the furnace until cold. Local conditions in heat treatment of steel must be taken into consideration for what is advisable in one place may not be practical in another place.

Repairing Cylinder Cap of Air Compressor Governor

BY F. W. B.

The ½-in. pipe thread in the cylinder cap body of an air compressor governor is often found badly worn, allowing a loose fit for the thread end of the diaphragm body or Siamese fitting. As long as the cap has good close threads, the diaphragm portion or the Siamese fitting can be safely turned to suit the angle or direction of the controlling pipes, but loose threads many times allow the hexagonal wrench portions above to strike the top of the cap with the connections in decidedly contrary directions.



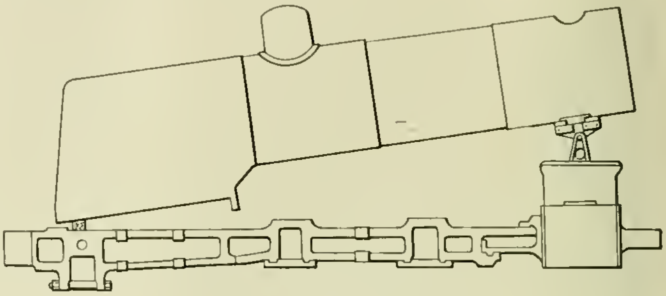
Cylinder Cap After Being Repaired

The illustration shows a quick and inexpensive method of repairing the caps where a number of them can be done at a time. The cap *A* is drilled out for a ¾-in. pipe thread, tapped and a ¾-in. to ½-in. reducing bushing screwed firmly into it. The square of the bushing is then cut off flush with the top of the cap. This affords a good ½-in. thread, perhaps a little small, but just right to take the thread of a body or Siamese fitting *B*, itself somewhat worn. The idea is simple, but provides a most effective way to remedy this defect.

Stool for Supporting Front End of Boiler

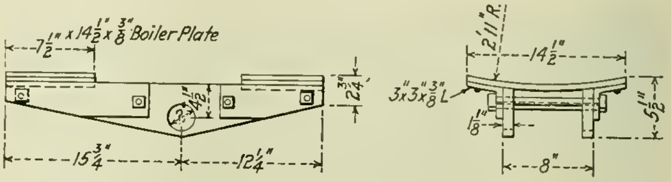
BY E. A. MILLER

When a new saddle is to be applied to a locomotive, it is bolted between the front ends of the frames, and the boiler is put in place. The top flange of the saddle is chalked or painted all around and a line scribed along the sides, front and back of the saddle ¼ in. or any convenient depth below the boiler, to follow as a guide in chipping the saddle to the proper contour. After being so marked the front end of the boiler is lifted up and the stool set in place as illustrated.



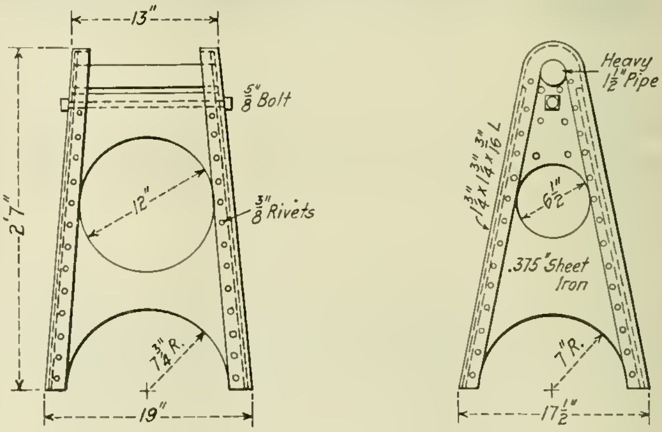
Sketch Showing Application of Stool

The frame of the stool is made of 1¾ in. by 1¾ in. by 3/16 in. angle iron bent at the top around heavy 1½ in. wrought iron pipe, which extends from one side to the other. The frame is stiffened by ⅜-in. sheet iron riveted to the angle irons as shown. A 6½-in. hole is cut in the sides and 12-in. holes in the front and back. The bottoms are cut out as shown.



Fulcrum Plate

The fulcrum plate consists of two 1⅛-in. by 28-in. wrought iron plates, cut to the shape shown and provided with 2-in. holes. The fulcrum plate rocks on a heavy 2-in. wrought iron pipe. Four pieces of 3 in. by ⅜ in. angle are bolted to the plates, and curved plates extend from side to side. These curved plates are made of ⅜ in. boiler plate and are riveted to the angle irons, the rivets being countersunk on top.

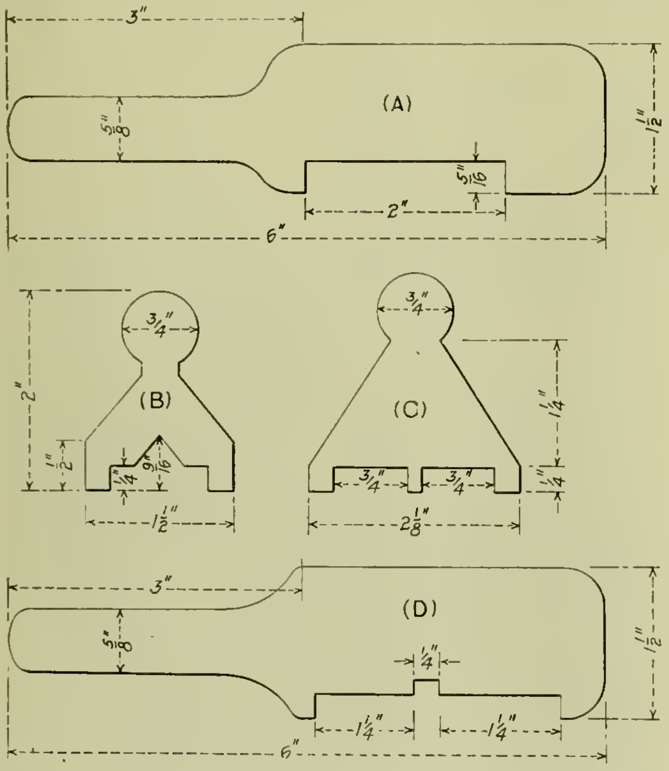


Details of Stool Construction

Standard Gages Facilitate Repairing Valves in Air Brake Department

BY F. A. SKINNER
Air Brake Foreman, Santa Fe Reclamation Yard, Corwith, Ill.

By the use of comparatively simple gages, it has been possible to save a large amount of material and greatly facilitate the work of repairing the various valves used in the air brake equipment. The gages and tools used for this repair work, the majority of which are home-made, have proved their value. The gages are made of 1/16-in. boiler steel carefully shaped to the forms shown. Referring to the illustration, *A* is a gage for testing the springs in pressure retaining valves. There is a tendency among many repair men to stretch this spring with the idea of increasing its tension and thereby preventing the retainer from leaking down. The use of gage *A* will detect springs that have been stretched and they may be replaced by standard springs. This will assure the correct action of the pressure retainer, thereby preventing slid flat wheels.



Gages Used in Air Brake Repair Work

Gage *B*, shown in the illustration, was devised for the purpose of testing the diaphragm in the maximum pressure head of the pump governor. To use the gage, the parts of the head are assembled and the gage is placed directly over the diaphragm or valve. If it fills the opening, the valve is of the proper length and, if not, it is too short. A new valve can then be installed and no trouble will result from leaky diaphragm valves.

Gage *C* is used to measure the length of the regulating valve in a slide valve feed valve after it has been assembled and the spring box removed. The gage is used in the manner of a straight edge and shows at a glance whether the regulating valve is of the proper length. The slide valve feed valve is one of the most difficult parts of the air brake equipment to repair and its action is absolutely dependent upon the correct length of the regulating valve, so the importance of this gage can be readily appreciated.

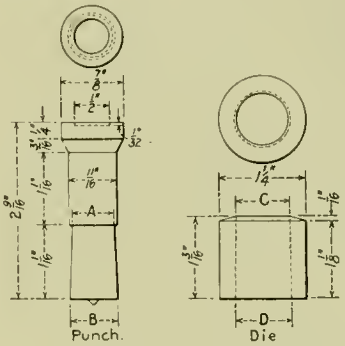
Gage *D* is provided for testing the vent valve in an auxiliary release valve, and by its use much time can be saved by assuring that the vent valve is not too short before making the test. To test the vent valve, the part containing the rubber seat is placed in the 1/4-in. slot and if the top of the vent valve touches the top of the gage, the valve is of the proper length and can be reseated. Upon testing the release valve, the length of the vent valve will be found to be correct.

Power Punches and Dies*

The punch and die is one of the most abused tools in the shop. It has to work under all kinds of conditions. Sometimes it has lubrication and more times not, and seldom does the operator take pains to see that the punch is central with the die.

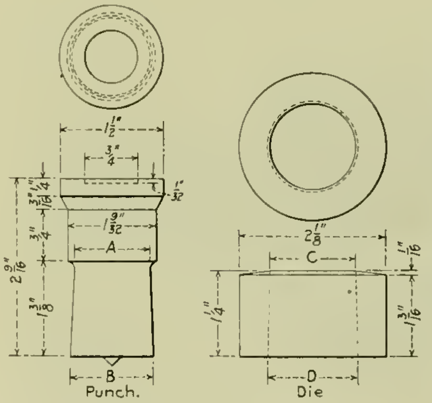
C. M. & St. P. Practice

Fig. 1 shows Chicago, Milwaukee & St. Paul standard punches and dies. The punches are made on automatic machines, the large ones at a labor cost on the machine of 4½ cents each, and the small ones at 3½ cents each, and one cent each for tempering them.



Size of Holes Punched	A	B	C	D
11/16" Diam.	5/8"	11/16"	3/4"	13/16"
9/16" Diam.	1/2"	9/16"	5/8"	11/16"
13/32" Diam.	3/8"	13/32"	7/16"	15/32"
11/32" Diam.	5/16"	11/32"	3/8"	13/32"
5/16" Diam.	9/32"	5/16"	11/32"	3/8"

Tool Steel



Size of Holes Punched	A	B	C	D
1 3/16" Diam.	1 1/8"	1 3/16"	1 1/4"	1 5/16"
1 1/8" Diam.	1 1/16"	1 1/8"	1 3/16"	1 1/4"
1 1/16" Diam.	1"	1 1/16"	1 1/8"	1 3/16"
1" Diam.	15/16"	1"	1 1/16"	1 1/8"
15/16" Diam.	7/8"	15/16"	1"	1 1/16"
7/8" Diam.	15/16"	7/8"	15/16"	1"
13/16" Diam.	3/4"	13/16"	7/8"	15/16"
3/4" Diam.	11/16"	3/4"	13/16"	7/8"
9/16" Diam.	1/2"	9/16"	5/8"	11/16"
13/32" Diam.	3/8"	13/32"	7/16"	1/2"
11/32" Diam.	5/16"	11/32"	3/8"	13/32"
5/16" Diam.	9/32"	5/16"	11/32"	3/8"

Tool Steel

Fig. 1—Large and Small Shank Punches and Dies, C. M. & St. P.

Fig. 2 shows a punch and die for punching convex steel staybolt nuts. These nuts are used in the firebox on radial staybolts, and on crown sheets. The nuts are punched from boiler steel and tapped in a nut tapping machine. Some trouble has been experienced on these punches, the face of the punch pulling off in the stripping. This has been overcome by putting a double taper on the body of the punch; that is, giving it the regular clearance for half of the body and reversing the taper on the other half, so that the punch will act as a drift to open the top of the sheet where it has drawn in. This makes the sheet strip from the punch very easily. More damage is done to a punch in stripping than in punching.

The punches are made of 90 to 100-point carbon tool steel. The larger sizes, when in bad condition on the cutting end, are annealed and reclaimed to a smaller size.

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*From a paper read before the American Railway Tool Foremen's Association.

A. T. & S. F. Practice

The sketches show sizes of the standard punches and dies used. These may be ordered on requisition, by a symbol number from one central point—Topeka, Kan.—where a sufficient stock is kept on hand to meet the requirements of the different shops along the line. These tools are mostly bought from the manufacturers.

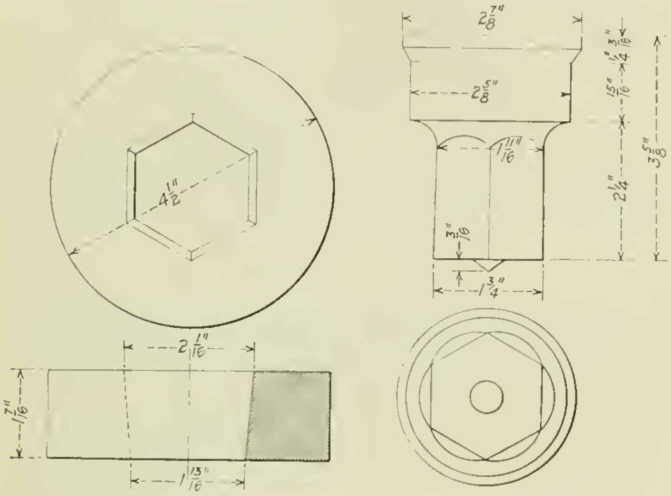
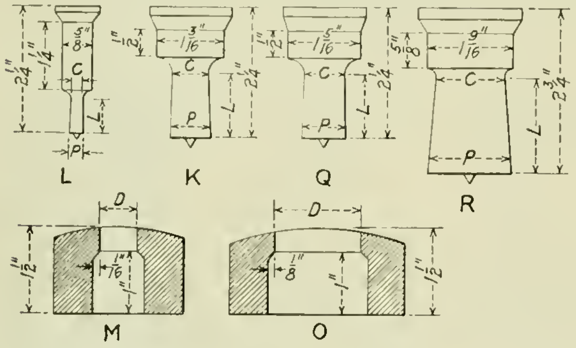


Fig. 2—Punch and Die for Convex Steel Staybolt Nut

In establishing a standard, the size and shape of the body of the punches and the diameter of the die are the essential points to consider, as the length in a good many cases will depend on the nature of the work and the construction and style of the machine.



Punch				Die		Punch				Die	
Sym. No.	P	C	L	Sym. No.	D	Sym. No.	P	C	L	Sym. No.	D
L102	3/16"	5/32"	33/64"	M102	7/32"	K113	7/8"	27/32"	1 13/64"	M113	23/32"
L103	1/4"	7/32"	35/64"	M103	9/32"	K114	15/16"	29/32"	1 15/64"	M114	31/32"
L104	5/16"	9/32"	37/64"	M104	11/32"	K115	1"	31/32"	1 17/64"	M115	1 1/16"
L105	3/8"	11/32"	39/64"	M105	13/32"	K116	1 1/16"	1 1/32"	1 19/64"	M116	1 1/8"
L106	7/16"	13/32"	41/64"	M106	15/32"	K117	1 1/8"	1 3/32"	1 21/64"	M117	1 3/16"
L107	1/2"	15/32"	43/64"	M107	17/32"	K118	1 3/16"	1 5/32"	1 23/64"	M118	1 1/4"
L108	9/16"	17/32"	45/64"	M108	19/32"	Q119	1 1/4"	1 7/32"	1 41/64"	M119	1 5/16"
L109	5/8"	19/32"	47/64"	M109	21/32"	Q120	1 5/16"	1 9/32"	1 43/64"	M120	1 7/16"
K110	11/16"	21/32"	1 7/64"	M110	23/32"	R121	1 3/8"	1 11/32"	1 45/64	0121	1 1/2"
K111	3/4"	23/32"	1 9/64"	M111	25/32"	R122	1 7/16"	1 13/32"	1 47/64"	0122	1 9/16"
K112	13/16"	25/32"	1 11/64"	M112	27/32"	R123	1 1/2"	1 15/32"	1 49/64"	0123	1 5/8"

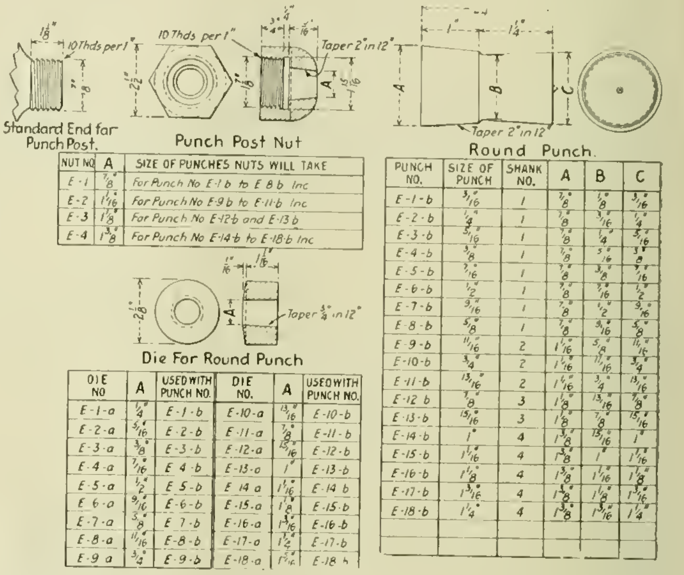
Fig. 3—Standard Punches and Dies—A. T. & S. F.

Four different sizes of punches and two of dies are shown, although in practice the larger sizes are not much used, as the average punching machine will not handle work large enough to require them.

For the ordinary boiler shop punch the coupling nut for the holder is made to fit the larger punch and a bushing or reducer is used to adapt the smaller, or symbol *L* punch, to the same coupling nut. As the punches and dies are of the same length, blocking is not required, unless the punches have been reworked and made shorter.

N. & W. Practice

There were no less than 15 machines distributed in different departments of the Norfolk & Western shops at Roanoke, Va., each having a different type of punch and punch post, with coupling nuts ranging from 1½ in. in diameter to 2¼ in. in diameter, with threads 10 to 14 per inch. Some held the punch in place with set screws, which often could neither be tightened nor loosened. An outfit for one machine was designed that could be standardized and all the machines have been fitted with the standard equipment.



NUT NO.	A	SIZE OF PUNCHES NUTS WILL TAKE
E-1	7/8"	For Punch No E-1 b to E 8 b Inc
E-2	1 1/16"	For Punch No E-9 b to E-11-b Inc
E-3	1 1/8"	For Punch No E-12-b and E-13 b
E-4	1 3/8"	For Punch No E-14-b to E-18-b Inc

DIE NO	A	USED WITH PUNCH NO.	DIE NO.	A	USED WITH PUNCH NO.
E-1-a	1/4"	E-1-b	E-10-a	13/16"	E-10-b
E-2-a	5/16"	E-2-b	E-11-a	7/8"	E-11-b
E-3-a	3/8"	E-3-b	E-12-a	15/16"	E-12-b
E-4-a	7/16"	E 4-b	E-13-a	1"	E-13-b
E-5-a	1/2"	E 5-b	E 14 a	1 1/16"	E-14 b
E 6-a	9/16"	E-6-b	E-15-a	1 1/8"	E-15-b
E-7-a	5/8"	E 7-b	E-16-a	1 3/16"	E-16-b
E-8-a	11/16"	E-8-b	E-17-a	1 1/4"	E-17-b
E-9 a	3/4"	E-9-b	E-18-a	1 5/16"	E-18 b

PUNCH NO.	SIZE OF PUNCH	SHANK NO.	A	B	C
E-1-b	3/16"	1	7/8"	1/8"	3/16"
E-2-b	1/4"	1	7/8"	3/16"	1/4"
E-3-b	5/16"	1	7/8"	1/4"	5/16"
E-4-b	3/8"	1	7/8"	5/16"	3/8"
E-5-b	7/16"	1	7/8"	3/8"	7/16"
E-6-b	1/2"	1	7/8"	7/16"	1/2"
E-7-b	9/16"	1	7/8"	1/2"	9/16"
E-8-b	5/8"	1	7/8"	9/16"	5/8"
E-9-b	11/16"	2	1 1/16"	5/8"	11/16"
E-10-b	3/4"	2	1 1/16"	11/16"	3/4"
E-11-b	13/16"	2	1 1/16"	3/4"	13/16"
E-12 b	7/8"	3	1 1/8"	13/16"	7/8"
E-13-b	15/16"	3	1 1/8"	7/8"	15/16"
E-14-b	1"	4	1 3/8"	15/16"	1"
E-15-b	1 1/16"	4	1 3/8"	1"	1 1/16"
E-16-b	1 1/8"	4	1 3/8"	1 1/16"	1 1/8"
E-17-b	1 3/16"	4	1 3/8"	1 1/8"	1 3/16"
E-18-b	1 1/4"	4	1 3/8"	1 5/16"	1 1/4"

Standard Punch Post, Nuts, Dies and Punches, Norfolk & Western

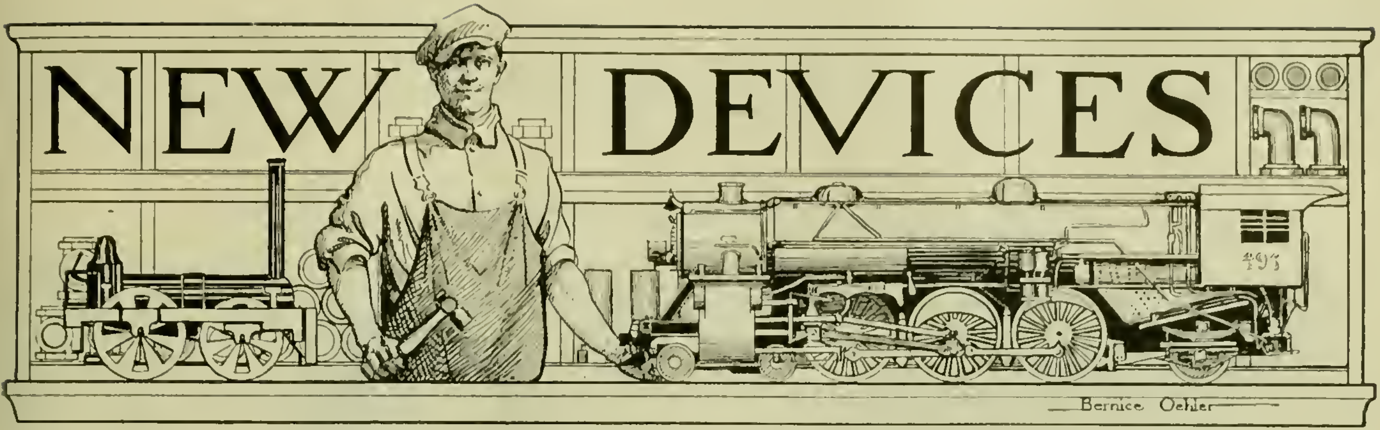
All punch posts have threaded ends 1⅞ in. in diameter, 10 threads per inch. The standard punch is 2¼ in. long. Four sizes of coupling nuts are used:

No. 1 nut taking size 3/16 in. to 5/8 in.—⅞ in. stock.
No. 2 nut taking size 11/16 in. to 13/16 in.—1 1/16 in. stock.
No. 3 nut taking size ⅞ in. to 15/16 in.—1⅛ in. stock.
No. 4 nut taking size 1 in. to 1¼ in.—1⅜ in. stock

The details of this equipment are shown in Fig. 4.

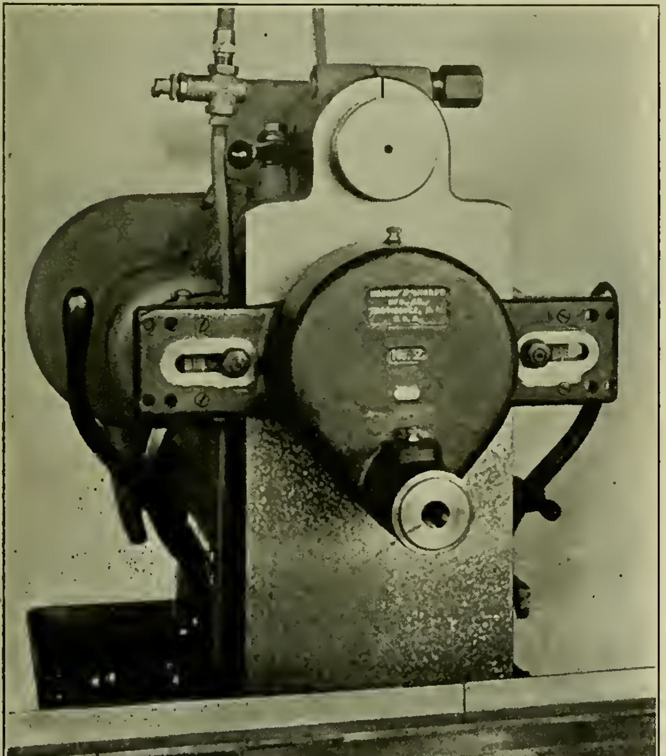
Discussion

The discussion was confined largely to the operation of punches rather than to the development of a standard type of punches, couplings and dies. Owing to the difficulty of getting satisfactory production in drilling flue holes in front tube sheets the St. Louis-San Francisco is experimenting with a spiral punch, sized to leave 1/16-in. stock in the hole to be finished by reaming. So far, it has been found that this punch does not disturb the metal as much as had been expected. No other railroad represented at the convention has taken up this proposition. The Santa Fe practice is to punch a 1-5/16-in. hole and then run through a reamer or two-lip drill. At one time sixty of these holes were drilled an hour, but when the war broke out the schedule was cut to forty an hour and actual production now does not exceed twenty-five an hour.



Easily Applied High Speed Milling Attachment

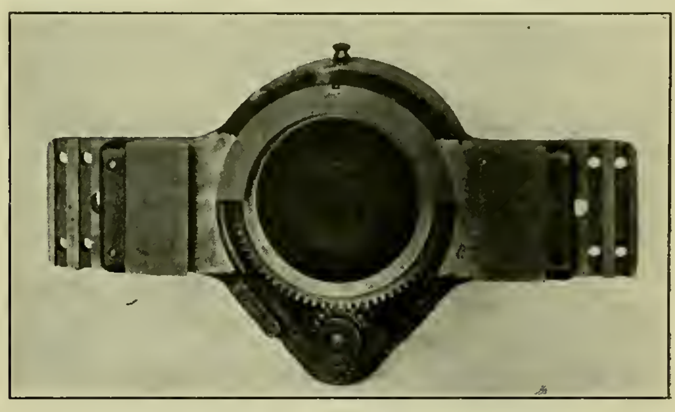
THE accompanying illustrations show a new design of high speed milling attachment made by the Brown & Sharpe Manufacturing Company, Providence, R. I., for use on milling machines of their manufacture. As will be noted, the mechanism is simple in construction and easily attached to the milling machine, no auxiliary fixtures being required. The bracket and spindle support is a one piece casting of substantial construction, so designed as to protect the mechanism from dirt and injury.


Brown & Sharpe High Speed Milling Attachment

The attachment is built in two sizes: the No. 1 for the smaller machines and the No. 2 for the larger machines. The No. 2 size is adaptable by means of adjustable gib stops to the larger machines having columns with different widths of face, thus eliminating the necessity of a separate attachment for each different size of machine column.

The positive means of locating the attachment is particularly noteworthy. To assure a positive vertical position, the attachment is provided with a locating segment which rests upon the spindle box of the machine. This spindle box projects beyond the face of the column and acts as a centering guide. The horizontal position is determined by first tightening the gib on the right hand side of the attachment, thereby locating the attachment. The gib on the left hand side securely clamps the attachment to the face of the column. This affords a large bearing surface, assuring rigidity and making the attachment practically an integral part of the machine.

Particular attention has been given to the drive that it may be positive and simple, the only gearing being the large ring gear that fits on the taper nose spindle of the machine and the pinion on the attachment spindle. The large gear is made with an internal taper, ground to fit on the taper nose of the machine spindle and is held in position by the regular cutter driver. This gear is made of machinery steel and left soft to provide a smooth drive and eliminate chatter and the objectionable "ring" often produced by hardened gears at high speed. On the No. 2 attachment the pinion is heat treated and keyed to the attachment spindle, while on the No. 1 attachment the teeth of the pinion are cut directly on the spindle.


Rear View of High Speed Milling Attachment

The spindle is hardened and ground and runs in a long phosphor bronze bearing, the bearing being tapered so that wear is taken up by tightening an adjusting nut, thereby forcing the spindle into the taper. Once having adjusted the spindle, a small set screw securely clamps the adjusting nut in position. End thrust is taken by hardened steel and babbitt washers located directly behind the shoulder on the front end of the spindle. The front end of the spindle has a taper hole to receive cutters, the smaller attachment having a No. 7 taper hole and the larger one a No. 9 taper hole. Oiling the spindle bearing is effectively taken care of by means of an oil pocket on the front of the attachment containing wool, which insures a constant and even distribution of the oil at all times.

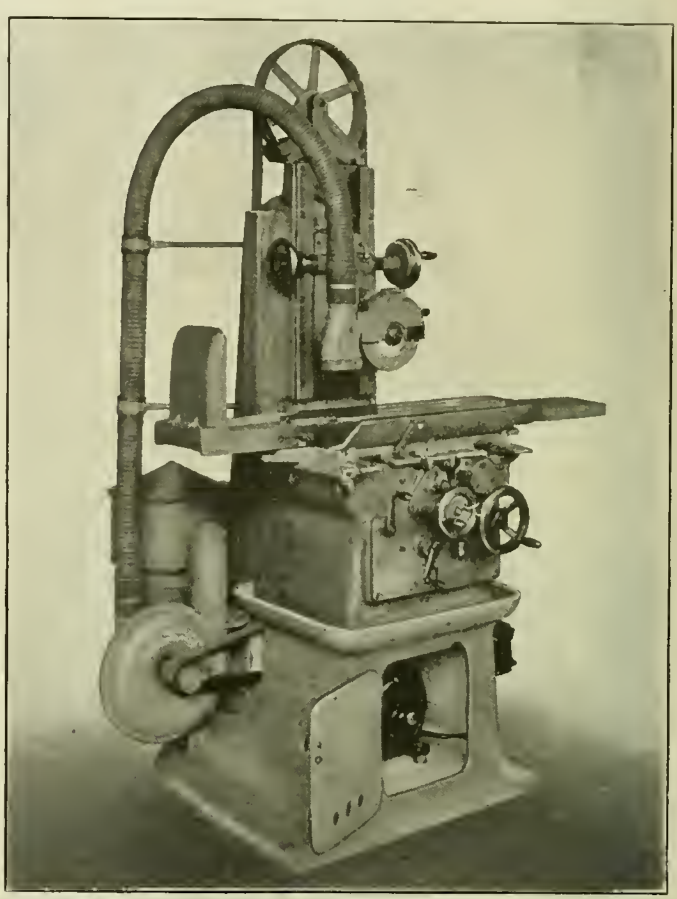
The cutter is held in position by the taper in the spindle and is driven by the tenon. Cutters are readily removed by a releasing bolt which provides a positive means of ejection. This bolt is a part of the attachment and remains in the spindle.

Exhauster Attachment for Surface Grinder

MODERN requirements for the safety and health of the employee demand an efficient device for disposing of the dust generated by grinding machines, especially surface grinders, when operating without the use of water, which is frequently necessary. Where these machines are not placed in groups to be served from one central exhaust system, it is desirable to have the individual machine equipped with its own unit, and in many cases it is really more economical to have each machine of a group individually equipped, as the exhauster is then running only while the machine is in operation. This is especially true where individual motor drive prevails.

Realizing the importance of collecting as much of this dust as practicable, the Abrasive Machine Tool Company, East Providence, R. I., has designed a complete new system for its machines, as shown in the illustration. The exhauster is a machine-tool-built product, equipped with S-K-F ball bearings, and aluminum fan, running at 4,000 r. p. m. The exhauster is connected with the aluminum dust collector on the wheel hood by means of flexible wire-insert rubber suction tubing. The wheel dust is drawn in through the flexible tubing, and forced into the centrifugal drum attached to the rear of the machine, where the dust is separated and deposited at the bottom of the cone. The free air passes out through a circuitous route, and, it is stated, is practically dustless. The accumulation of dust can be removed by unscrewing a cap at the bottom of the separator drum.

The illustration shows the dust exhauster attachment applied to one of the Abrasive Machine Tool Company's No. 3 surface grinders but the application could easily be made to many other types of machines. The question simply resolves itself into a matter of piping to the machine and designing the proper collector for sucking in the dust at the point where it is generated. Application of the parts is then easily made.



Motor Driven Dust Exhauster System

Self-Loading Type Electric Truck

AN industrial self-loading truck of improved design has recently been placed on the market by the Industrial Truck Company division of the Cowan Truck Company, Holyoke, Mass. The truck is of all-steel construction and is guaranteed for 5,000 lb. capacity. It has a quick acting elevating mechanism and elevates in five seconds when equipped with 28 cells and six seconds with 21 cells.

The lifting mechanism is operated by an independent, heavy duty, series wound motor and worm gear reduction. The platform lifts vertically, the rise being 4½ in. The platform may be stopped at any point going up or down, and requires only three seconds for full lowering. The rear end is equipped with a heavy bumper which effectually takes all shocks, and protects the lift platform. A drawbar attachment also is provided which enables the truck to be used as a light duty tractor.

An automatic brake and circuit breaker application, four-wheel steer, single reduction worm drive of the power axle and easy accessibility of batteries, lifting, driving and control mechanism are features of the truck. It will operate in intersecting aisles 60 in. wide.

The extreme turning radius, outside point, is 7 ft. 10 in. By folding the foot pedal and steering handle into a vertical position, the overall length is shortened for use on elevators. The length is 102 in. overall or 91½ in. with the

I. T. C. Self-Loading Electric Truck

step raised. The width is 36 in. overall and the height over steering shaft head 51 in. Either alkaline or lead batteries are used. The controller is of the drum type with three speeds forward and three reverse.

The new truck has been subjected to rigid tests under actual operating conditions, and promises enduring service due to its all-steel construction, low center of gravity, and general compactness and ruggedness.

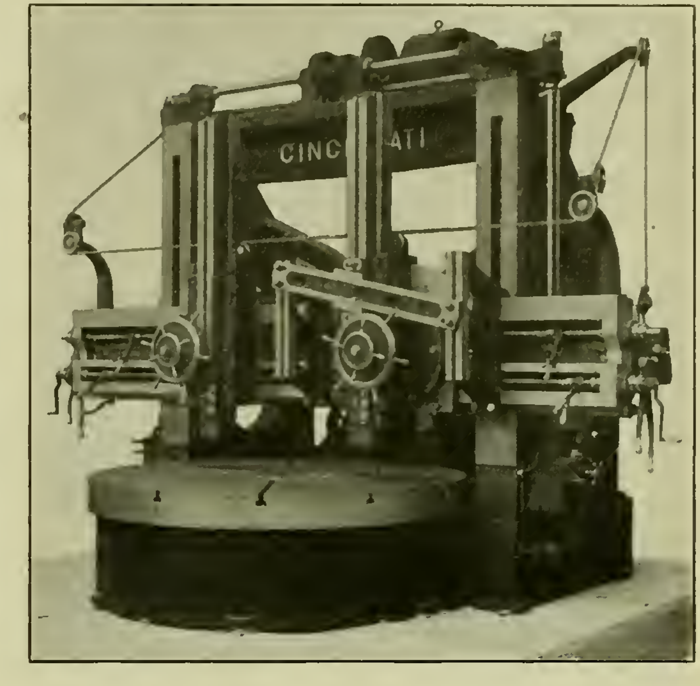
Taper Attachment Applied to Boring Mill

FOR turning and boring tapers approaching nearly a horizontal line to which swiveling the head is not adaptable, a taper turning and boring attachment has been designed for use on boring mills manufactured by the Cincinnati Planer Company, Cincinnati, Ohio. The illustration shows the attachment applied to an 8 ft. mill but it can be adapted to use on all sizes from 42 in. up to 12 ft.

The component parts such as sine bar supports, sine bar, and sine bar guide are all clearly shown in the illustration. To provide up and down adjustment to the ram without loosening the sine bar and thereby changing its position, the faces of the rams are specially machined and fitted with a tee slot in length equal to the up and down travel.

When mounting, the sine bar supports, sine bar guide and sine bar are placed in position loosely and clamped securely in place after the proper angle has been determined. The power feed to the ram is then disengaged by means of the small handwheel making it ready for operation. The use of the taper attachment is recommended for angles up to and including 18 deg.

When the taper to be turned on a boring mill is so nearly horizontal that it is beyond the range to which the head can be swiveled, the transverse and vertical feeds are sometimes used together but this method is inconvenient. The correct setting of the swivel head must be obtained by trial but with the taper attachment the setting can be made directly.

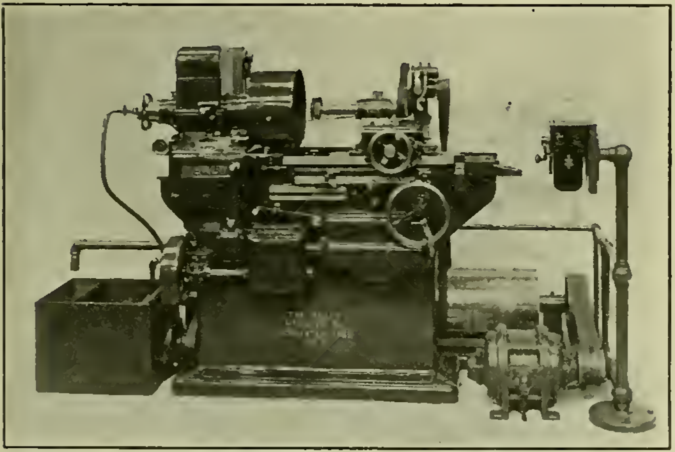


Cincinnati Taper Turning and Boring Attachment

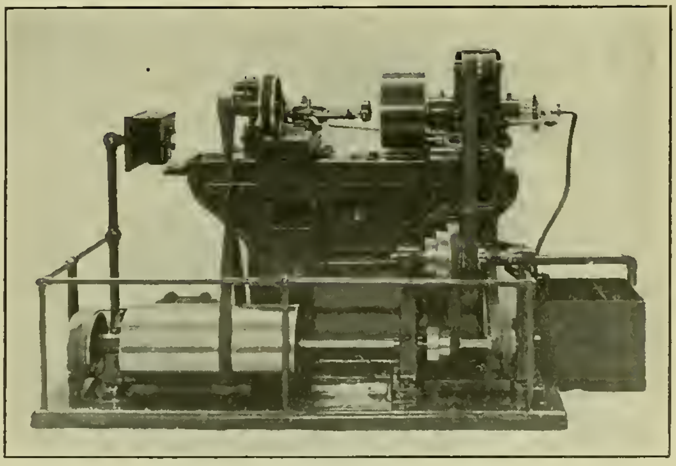
New Motor Drive for Internal Grinder

WITH the idea of securing a more compact design, together with other advantages, a new motor drive unit for the Nos. 70 and 75 internal grinders has been designed by the Heald Machine Company, Worcester, Mass. The old solid idler is eliminated and a new flexible idler gives proper tension to the wheel-head belt, as well as the vertical belt between the drum and the idler.

There is a slight change at the head end where power is taken for the work head. A swinging arm is furnished which swivels on a bracket that holds the driving cones for giving the various speeds to the work head. The swinging arm is connected to the work head with a rod which is so fastened that it will allow swiveling the head either way and still keeping the proper belt tension. In other words, the rod acts as a distance feed. Providing the head has been swivelled around to a certain angle and the proper tension is not fur-



New Motor Drive for Heald No. 71 Grinder



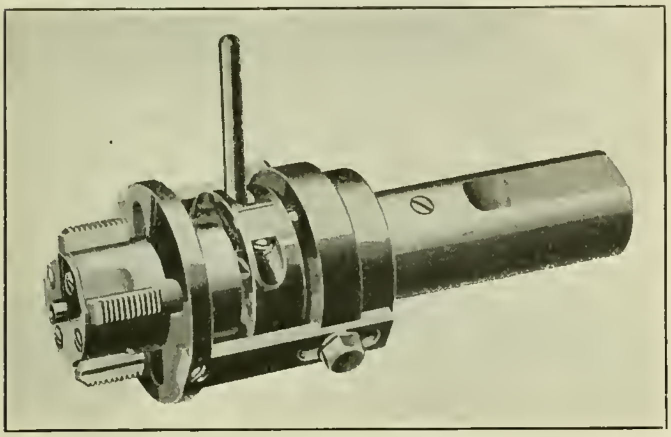
Rear View Showing Drive Arrangement

nished, the nut on this rod may be adjusted to give the proper tension.

Attachment of the new motor drive arrangement is very simple since it only requires moving the standard guard over the work-head pulley, replacing it by a box containing the idler pulleys.

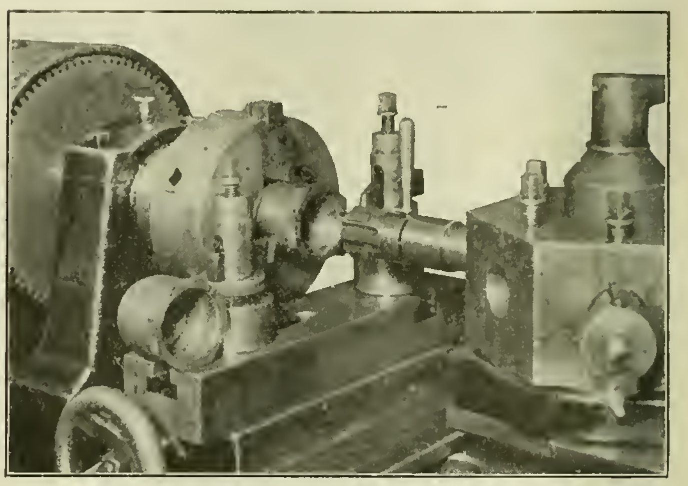
Improved Automatic Collapsing Tap

AUTOMATIC collapsing taps are becoming more and more a necessity for threading operations and when introduced into railway shops, for example, will effect economies many times greater than their cost. Automatic taps are necessary because of the requirement for accurate work and as a safety feature to prevent spoiling work, but their greatest value lies in the greater production made possible.



Namco Automatic Collapsing Tap

The National Acme Company, Cleveland, Ohio, has recently developed and placed on the market an improved automatic collapsing tap known as the Namco, which is designed to fulfill the requirements stated above. The taps are provided with an inside trip, or outside trip, as illustrated, and can be furnished in all sizes for ordinary tapping operations. They are economical for use on general shop work because of their ease of adjustment and quick adaptability.



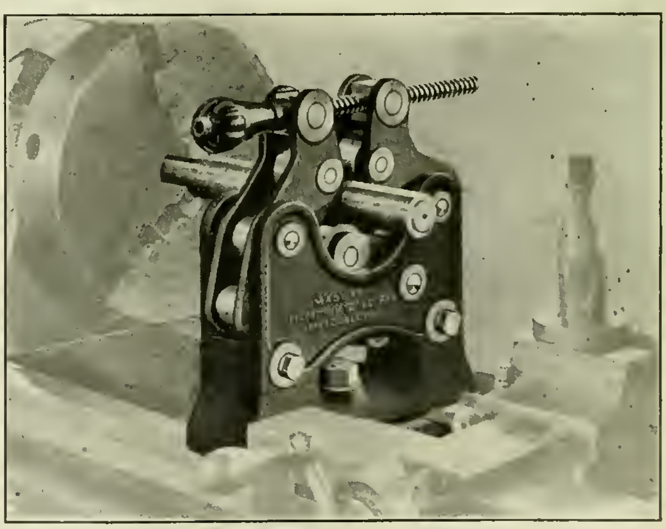
Collapsing Tap Used for Threading Operation on Turret Lathe

The illustrations show a general view of the tap and its use in a practical threading operation on a turret lathe. As an example of its adaptability, an inside trip Namco tap can be equipped with a cammed tripping sleeve and reamer blades for reaming instead of standard chasers for thread cutting. While this is strictly special equipment, it shows the adaptability of the collapsing principle to smooth and positive collapsing action, as simple as throwing a gear out of mesh, and as positive.

Easily Applied Self-Centering Steady Rest

A STEADY REST has been developed recently by the McCrosky Tool Corporation, Meadville, Pa., with several special features and important advantages in operation. It is especially recommended for all operations to be performed on the end of a piece such as facing, boring, turning and practically all work that could be done on the old style steady rest. The self-centering feature is secured by means of three rollers which engage the work and are brought quickly and simultaneously toward the center by closing the jaws. The jaws are interacting, universal and therefore not independent. The three rollers are hardened and run on Hyatt roller bearings which reduces friction to a minimum. The power consumption is small and there are no contact points to wear off.

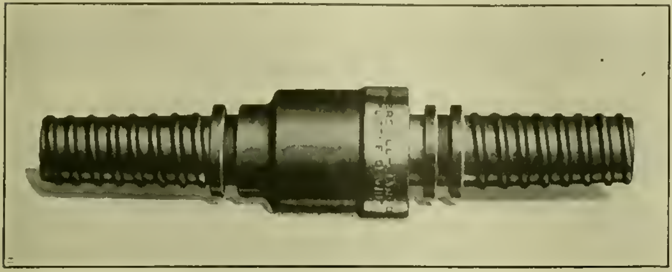
In operation the work is inserted in the lathe chuck and the steady rest placed in the desired position. The jaws are closed until the rollers engage the work and with a turn of the tightening screw, the machining operation may begin. Once adjusted to the lathe centers, the steady rest remains always adjusted and can be taken off and put on the lathe frequently in a few moments and without readjustment. A large range of diameters may be handled and the desired change made at any time without any adjustment except a few turns of the tightening screw. The No. 1 steady rest, illustrated, is designed for 12 to 18 in. lathes and has a range of ⅜ in. to 3¾ in. For soft, highly finished work, stationary cast iron jaws are recommended.



McCrosky Self-Centering Steady Rest

Hose Couplings for Pneumatic Tools

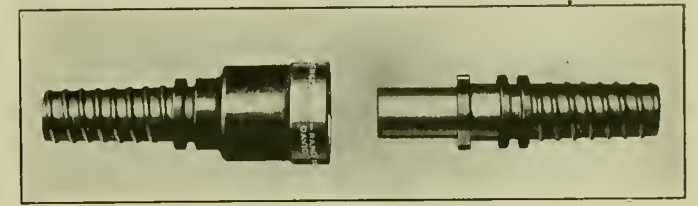
A HOSE COUPLING with several new and important features has recently been placed on the market by the Ingersoll-Rand Company, New York. It is called the "Little David" hose coupling and will be distributed as an accessory to the line of pneumatic tools manufactured by the Ingersoll-Rand Company. Hose couplings which become leaky after short use are the cause of serious air losses, whether in the small shop or the large plant using hundreds of hose connections. Another trouble commonly experienced with many couplings is jamming or sticking through some slight injury, making them difficult or almost impossible to connect or disconnect.


Little David Pneumatic Hose Coupling

The design of the new coupling has been made with the view to overcoming the above troubles. The main features claimed for it are sturdiness and simplicity, and an all around ability to stand lots of abuse without affecting its service. Actual tests over long periods of service have demonstrated its reliability. The coupling consists of two parts, male and female. The female end is fitted with a V-shape rubber gasket providing an air tight joint. The gasket is prevented from blowing out, should the coupling accidentally be disconnected under pressure, by a protective shoulder inside the coupling. The female end is exceptionally sturdy, there being no exposed parts which might be liable to injury and cause jamming or sticking.

The locking shoulders are heavy with large bearing surfaces, the locking spring being strong and durable. It can be replaced if necessary. The parts are made of a metal not subject to ordinary rusting or corrosion. The male end has a very liberal bearing in the female end, which assures alinement and long wear. Another feature is the absence of any outer sleeve exposed to injury. The air ports are straight and of uniform diameter, offering the least restriction to the flow of air.

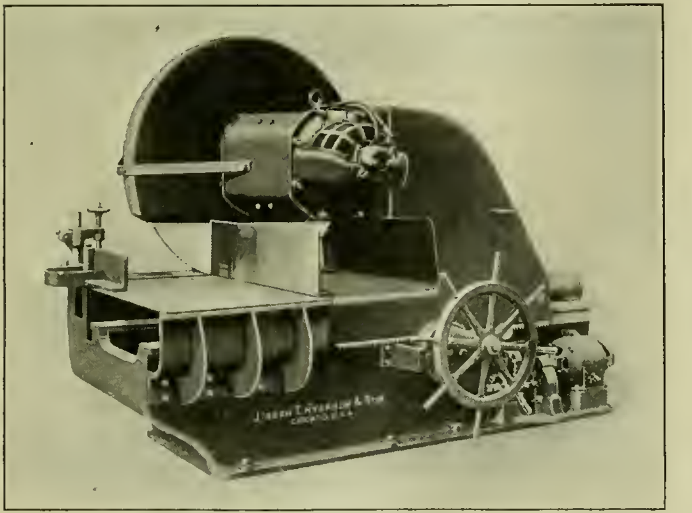
The coupling may be connected or disconnected by a quarter turn. A groove in the hose end of each part allows using a hose clamp to attach securely to the hose.

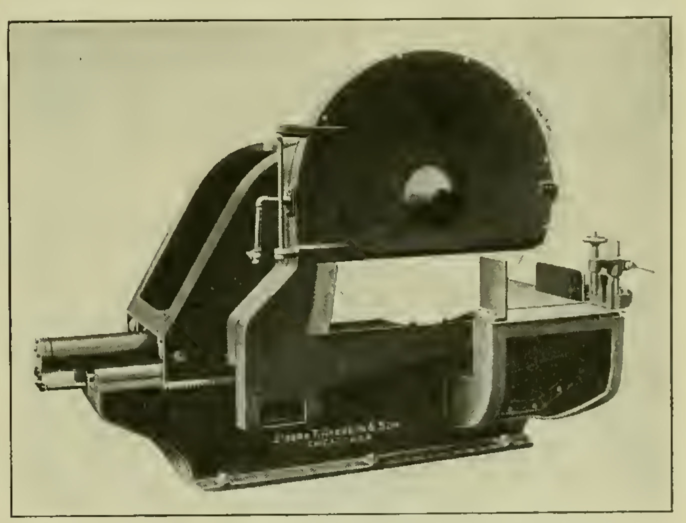

View of Coupling Parts Separated

These hose couplings are manufactured in ½ in. and ¾ in. sizes, which are interchangeable; that is, a ½ in. male piece may be used with a ¾ in. female end or vice versa. Gaskets are also interchangeable between the different sizes.

High Speed Friction Metal Cutting Saw

FOR the rapid cutting of structural steel shapes, the high speed friction saw, illustrated, has been developed recently by Joseph T. Ryerson & Son, Chicago. The machine consists of a heavy cast iron box base, on top of which is mounted a horizontal rolling carriage. The carriage operates on roller bearings, mounted on eccentric pins to provide for adjustment. The hood is of heavy sheet metal construction, one side being hinged for greater ease in examining or removing the blade.


Ryerson High Speed Friction Saw


View Showing Table Arrangement and Water Connections

The blades are made of a special grade of soft steel, balanced, hollow-ground and nicked on the edge to increase the friction. Each blade is held in a carefully balanced collar and is cooled by jets of water directed against the cutting edge. Ample power is provided by means of an enclosed motor, especially designed for heavy duty. In operation the saw blade is fed forward through the work by means of the hand wheel or by the electro-hydraulic feed. Power feed, when applied to the machine, is a complete unit consisting of an hydraulic cylinder and piston and a motor-driven pump. This feed is operated by a four-way valve conveniently located. Miter cutting is easily handled.

The new Ryerson friction saw is made in four sizes, similar in design and differing only in capacity. For shops handling lighter structural work, sizes No. 1 and 2 are recommended, with hand feed. For handling heavy structural work and work in railroad shops, sizes No. 3 or 4 are recommended, with power feed. Among the important advantages of this machine may be mentioned the fact that varying sizes and shapes of material can be cut in immediate succession without any adjustment of the machine. The work does not need to be clamped and the cutting operation is performed in a fraction of the time required by other means. The expense of operation is slight due to the entire absence of belts, fly wheels, etc., and the machine is easily operated by one man. From the standpoint of maintenance cost, the blades cost much less than slow speed saws and last longer.

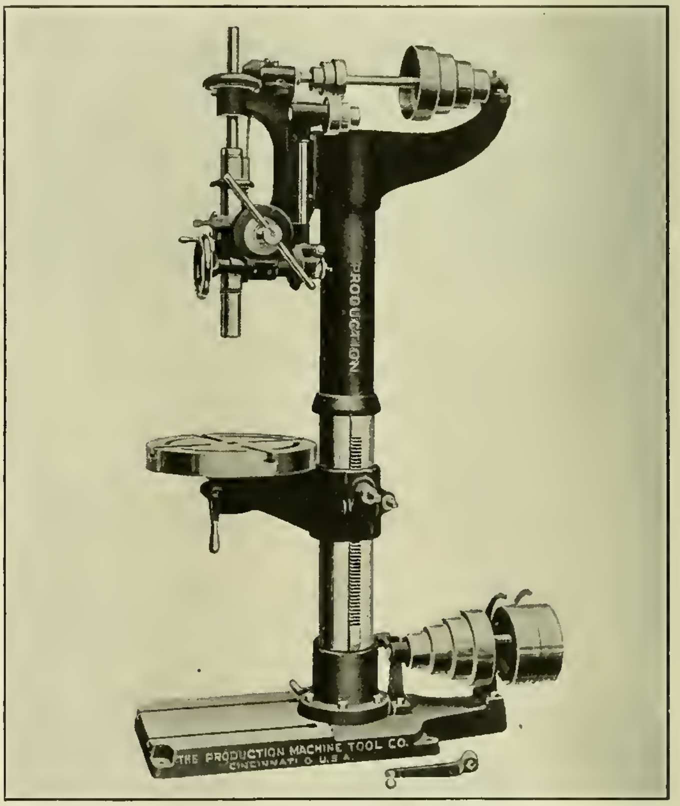
Twenty-Two Inch Drill With Stationary Head

THE Production Machine Tool Company, Cincinnati, Ohio, has recently developed and placed on the market a twenty-two inch upright drill with a stationary head and a capacity to drill, bore, tap, and ream holes up to and including 1¼ in. in diameter. This drill is bronze bushed throughout and the entire design is such as to make each part strong enough to withstand any ordinary strain to which it may be subjected. Centralized controls have been provided for convenience of operation and increased production.

The machine is regularly built with power feeds, but this feature may be omitted if desired. Back gears and tapping attachments can be added, together with the type of drive best suited to the conditions under which the machine is to be used; either regular tight and loose pulley, right angle or belted or geared motor drive. The unit system of construction has been followed throughout which eliminates individual fitting and assures interchangeability of parts. Bronze bushings are provided for all bearings and this prolongs the life of bearings in addition to facilitating the replacement when necessary. All details and units undergo a careful inspection and rigid test as to power before being assembled in the finished product.

The base of the machine is well ribbed and provided with T-slots, as is also the table. Clamping bolts are interchangeable and the radius slots in the table are especially convenient for some jobs. The table arm is of box construction in one casting, and has a wide bearing on the substantial tubular column. The drill head is of the box type with spindle driving gear bearing and head cast integral. This allows the spindle bearings to be bored and reamed at one setting with a resultant accurate alignment of the spindle.

The new drill is adapted for production work in assembly departments, as well as in jobbing and repair shops. Holes may be drilled to the center of a 22 in. circle. The spindle speeds when back gears are provided are 20, 33, 53 and 88 r. p. m. The spindle speeds without the back gears are 117, 196, 318 and 530 r. p. m. The power feeds per revolution of the spindle are .006, .010 and .105 in.



22-In. Stationary Head Production Drill

Lubricant for Locomotive Hub Liners

RAILROADS are constantly confronted with a great number of items of expenses which, seemingly small in themselves, total a large amount. One of these items is the expense resulting from the wear of locomotive hub liners. Failure properly to lubricate the various parts of locomotives, such as shoes, wedges, hub liners, etc., necessitates withdrawing locomotives from service and sending them to the shops on account of wear in excess of safe limits.

It is important to maintain driving box lateral play within specified limits and numerous devices have been invented and placed on the market to make it possible to remove driving boxes and reapply lateral liners without dropping the wheels. Much of this work can be eliminated, however, if the proper lubrication is applied in a systematic manner. Ordinarily a service of 30,000 miles may be expected before it is necessary to take up lateral play on driving boxes but in some cases where lubrication has been neglected the adjustment has to be made at the end of approximately 5,000 miles. Not only is the service of the locomotive lost for at least a day, but the operation itself is expensive and requires the time of several men.

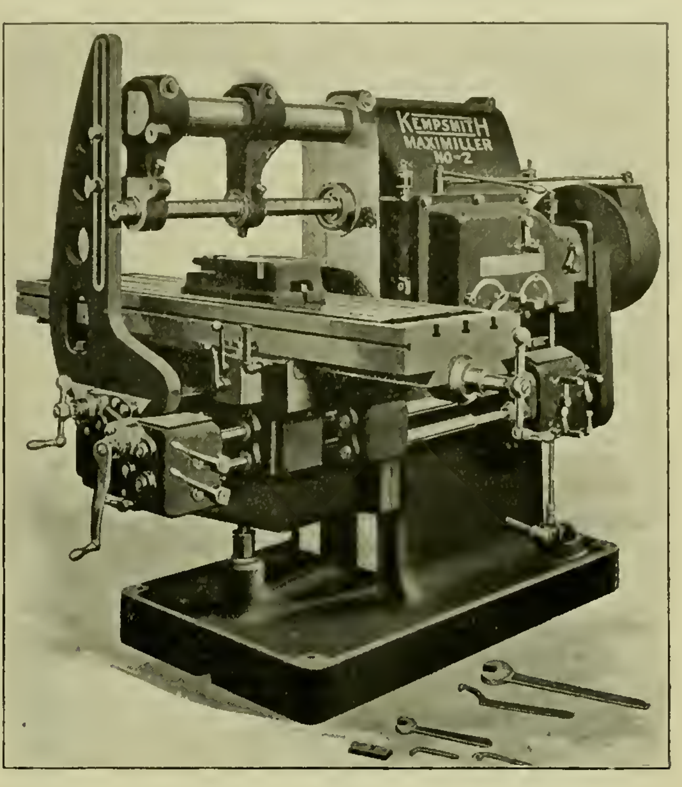
A lubricant known as Dixon's graphite hub liner grease has been developed by the Joseph Dixon Crucible Company, Jersey City, N. J., to be applied with a grease gun. It is claimed that this grease, properly applied, will greatly reduce the heating, wearing and cutting of working parts and lengthen the life between shoppings.

Plain Milling Machine for Medium Heavy Work

The No. 2 plain Maximiller, illustrated, is a recent addition to the line of milling machines made by the Kempsmith Manufacturing Company, Milwaukee, Wis. The machine is practically the same in all points of design as the Kempsmith No. 4 plain Maximiller and is adaptable for medium heavy classes of work. The new machine is designed for maximum rigidity, convenience of operation and efficiency in production. All important parts have been carefully designed in regard to relative weight and strength. The sloping column lines not only add to the appearance, but are true lines of strength. The large area of the base provides stability for the entire machine. The knee is of the solid top design with no opening, a construction which serves to resist clamping strains and the torsional effect of the table overhang. The column is well ribbed internally and has only a few small openings. The saddle, as shown in the illustration, is long, heavy and rigid. Drive to the table is located near the end of the saddle, which leaves the center solid, where most of the strain comes. The table is 12 in. wide with 56 in. working surface length.

The drive pulley is 15 in. in diameter, takes a 3½ in. double belt and runs at 400 r. p. m. It is mounted on ball bearings and with the clutch is enclosed in a protected housing. The control levers are conveniently located and proper safety devices are incorporated throughout. The speed change mechanism provides 18 changes of speeds ranging from ⅝ in. to 25 in. per minute in geometrical progression. Power quick traverse is available for all table movements without disturbing the set-up for whatever rate of speed may be in use. The longitudinal power quick traverse is at the rate of 100 in. per minute, while the cross and vertical travel is at the rate of 36 in. per minute.

By means of a train of gears, 18 changes of spindle speed may be obtained ranging from 16 to 400 r. p. m. When desired and especially ordered, the machine can be arranged for motor drive through a belt, in which case the motor recommended is 7½-hp. running at 1200 r. p. m.

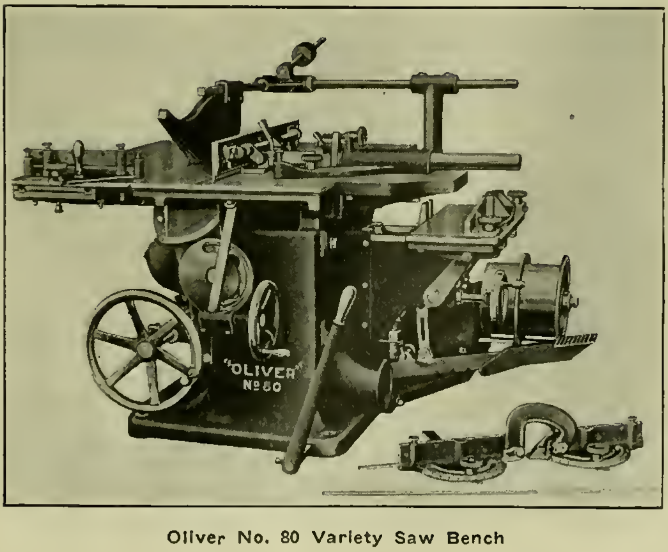


Kempsmith Plain Maximiller No. 2

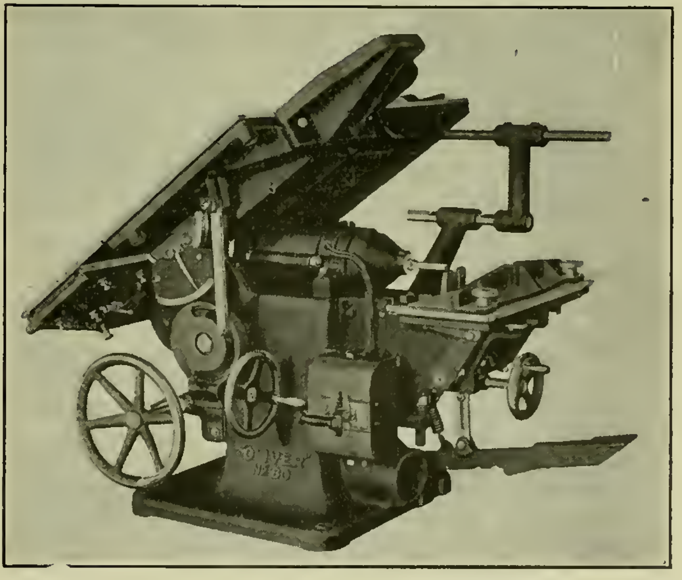
Belt or Motor Driven Variety Saw Bench

The machine illustrated, which can be arranged for either belt or motor drive, has been designed by the Oliver Machinery Company, Grand Rapids, Mich., to do ripping, cross cutting and dadoing in an efficient and thorough manner. It will cut a practically perfect miter and measure any angle quickly and accurately. It will cut off to lengths or rip to width, all without the operator doing any calculating or referring to a rule. The machine is rigid and accurate and parts are interchangeable. A 14-in. saw is regularly supplied, although a 16-in. saw may be used. The machine is arranged with or without a mortising and boring attachment.

One of the valuable features of this saw bench is the table, which is 36 in. by 44 in., tilting to 45 deg. to the left. The table has vertical adjustment and may be furnished either



Oliver No. 80 Variety Saw Bench



Variety Saw Bench With Table Tilted

plain or universal. The universal table shown in the illustration has a rolling section which is located at the left of the saw and rolls on ball bearing ways having vertical adjustment for alinement and for wear. The table may be moved several inches from the saw, permitting the use of dado or special heads. This table is said to operate so easily that it is well suited for production work and multiple cuts.

The universal ripping fence is furnished regularly with a quick adjustment of 12 in. without changing the locating pins to the next set of holes. The ripping fence may be tilted to an angle of 45 deg. and is adjusted to and from the saw by an extremely accurate micrometer adjustment. Miter cut off gages are supplied as regular equipment as well as auxiliary rods and stops which are intended to be used with gages.

For motor drive, a motor operating at about 1800 r. p. m. is mounted on a subbase bolted securely to the machine and belted directly to the main driving belt, eliminating the necessity of a countershaft.

The machine will rip up to 23 in. wide and cut off 32 in. wide by the use of the universal ripping table; will rip 27 in. wide and cut off 15 in. wide by the use of the plain table; will cut up to 3 in. thick with a 14-in. saw, or 4 in. thick with a 16-in. diameter saw, and will work dados up to 4 in. wide. With mortising and boring attachment it will bore holes 6 in. deep up to 2 in. in diameter, and will mortise holes up to ¾-in. square and 4 in. deep.

Measuring Temperatures in Stored Coal

A NEW DEVICE for indicating the thermal conditions of stored soft coal has been placed on the market recently by F. C. Thornley & Co., Inc., New York, and is called the Thornley coalometer. Bituminous coal has the well known property of spontaneously heating in certain spots and at varying depths. This heating does not always cause actual combustion, in the sense that the coal burns with the presence of flame, although this condition is often encountered. There does exist almost universally, however, in stored coal of this character, a slow combustion which is even more destructive than combustion by flame, owing to the fact that it cannot be so readily detected. This slow combustion goes on unnoticed throughout an ever-increasing zone beneath the surface of stored coal.

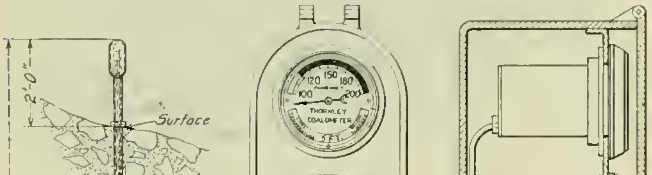


Fig. 1—Triple Unit Thornley Coalometer

The Thornley coalometer consists of a set of temperature indicators encased in a long pointed steel tube, carrying at varying depths metal bulbs (corresponding to the bulbs of thermometers), and at its upper end a set of dials and pointers, which indicate, under all atmospheric conditions, the exact temperature of the bulbs which actuate them. These units are forced down into the coal pile to definite depths and at various points, and collectively furnish definite data to the consumer as to the exact temperatures existing beneath the surface. If an accurate record of daily readings of these instruments is kept, the slightest rise in temperature is at once detected, and should it become excessive, the consumer can remove this particular portion of fuel, thus saving the greater part of the heating value of the coal which has started to dissipate.

Tests have shown that an installation of one coalometer each 50 ft. in both directions from its neighbor will efficiently indicate conditions of temperature below the surface. Thus the installation of one triple unit will protect approximately 900 tons of coal if the volume is about 50 ft. by 50 ft. by 16 ft.

A triple unit coalometer for use in coal piles from 15 ft. to 20 ft. deep is shown in Fig. 1. A galvanized steel tube, having a hardened steel diamond point drill at its lower end, carries three pressure bulbs at depths of 5, 10 and 15 ft., respectively. Tubes from these three bulbs register temperatures in deg. F. on three dials, by means of pointers provided for that purpose. The scale on each dial starts at 32 deg. F., and is colored black. At and above 120 deg. the scale is red, indicating excessive heat at a point in this zone, and warning the coal man to remove this portion of the coal. The depth of the hot spot is determined at a glance, for the dials are plainly marked 5 ft., 10 ft. and 15 ft., respectively. The dial showing the hottest temperature thus indicates the depth at which the heat is generating.

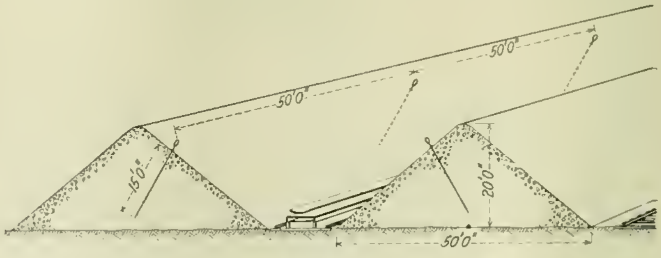


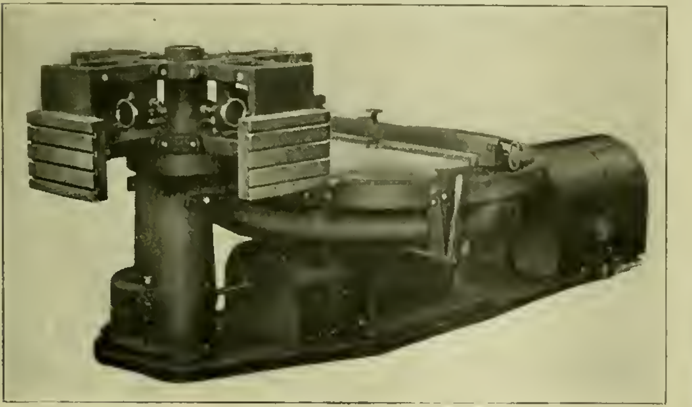
Fig. 2—Typical Installation of Coalometer

The dials are enclosed in weathertight metal cases with thick crystal faces, and the set is again enclosed in a galvanized cast iron case. This furnishes ample protection when not in use, and added protection when in service. A slidable pipe wrench is provided on each unit to aid the rapid and easy boring of the tube to the desired depth. A large, plainly-marked lug, 12 in. below the instrument head, determines the exact depth at which the coalometer is to be placed, and thus allows of no guess-work on the part of the man who does the installing. The construction throughout is very rugged and will allow of the rapid removal and stacking of one or more units repeatedly, without fear of damage to the temperature indicators themselves. These indicators are especially constructed to indicate accurate temperatures under the varying conditions encountered throughout the year. They will indicate exact bulb temperatures regardless of the temperature of the head of the instrument, and will retain their calibration under conditions of extreme vibration or violent shocks. They are easily readable and amply protected from breakage in handling.

Thornley coalometer units are supplied in two lengths, 12 ft. and 17 ft., which carry, respectively, two and three temperature indicators, a typical installation being shown in Fig. 2. The indicated temperatures when taken daily and recorded furnish complete knowledge of conditions beneath the surface of the coal.

Continuous Feed Disc Grinding Machine

The No. 24 grinder illustrated is made by the Gardner Machine Company, Beloit, Wis., and represents one of the latest developments in disc grinding machinery. It is a continuous feed disc grinder, being semi-automatic in operation and eliminating the labor expended in using the ordinary hand-operated machine. With any hand-operated machine, where the human element is the main factor in production, it is impossible to secure a uniform output all through the day. The operator grows tired and is certain to "let up a little" near the end of the day, thus affecting the total production possibly more than is realized.



Gardner No. 24 Continuous Feed Disc Grinder

The machine illustrated carries one horizontal disc wheel 54 in. in diameter and is provided with a revolving reel which carries four work tables. The work to be ground is attached to these tables by means of suitable fixtures mounted on them, and the revolving wheel brings it over the surface of the grinding wheel. The tables are automatically lowered onto the wheel. Pressure, to assure quick removal of stock, is secured through gravity, but by means of a compression spring this pressure may be adjusted. The weight of the table provides application of a uniform pressure, which can be increased by adding extra weight if the character of the work necessitates it. A micrometer stop screw makes it possible to remove stock to definite dimensions which may be required.

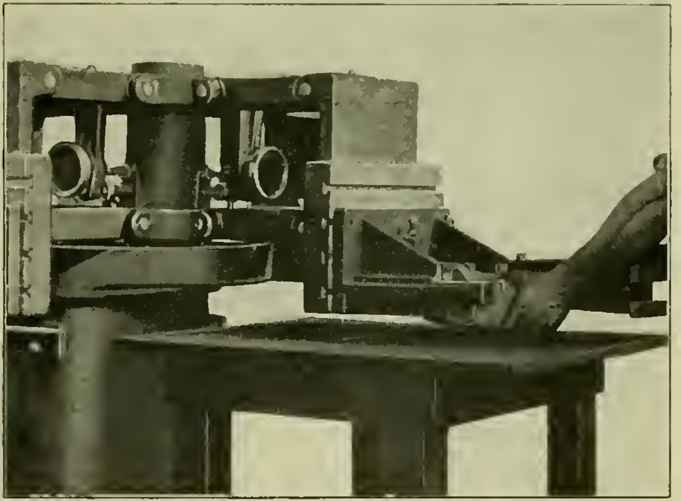
The revolving wheel is mounted on a vertical shaft of special piston rod stock 3½ in. in diameter, and is driven through worm, spur and bevel gears from the gear driving the main spindle of the machine. By means of change gears the reel may be made to revolve ¼, ½ or 1 r.p.m., thereby producing one, two or four finished pieces per minute. Other speeds, if desirable, may be obtained by substituting special gears.

The driving shaft is provided with a friction clutch, operated by a lever placed in a convenient position, which makes it possible to start or stop the feeding mechanism independently from the grinding wheel. The reel and the shaft which drives it are mounted in bronze bearings, all other shafts being carried in ball bearings. The gears are totally enclosed, which protects them from dust and dirt and allows them to be amply lubricated.

The feeding stand is bolted directly to the base plate upon which the machine is mounted and, to accommodate various sizes of work, has an adjustment of 6 in. along this base plate. Because the work tables are at right angles to the grinding wheel, accuracy of the work being ground is assured. A micrometer stop screw permits grinding to definite dimensions and also allows the grinding of a surface to a required relation with some other area on the piece. This is an important advantage.

Rigidity and strength are important features of this machine, which weighs about 7,600 lb. when crated for domestic shipment. The disc wheel is mounted on an extra large and heavy cast iron flange. The driving spindle is of large diameter and runs in two self-alining radial ball bearings. All down or end thrust is taken on a self-alining ball thrust bearing which contains ten 1¼ in. diameter balls. Power is transmitted to the disc wheel by hardened special steel bevel gears.

An extra pulley is mounted on the driving shaft for belting to an exhaust fan, which is set on the floor in back of machine. There is a dust channel cast into the base of the machine and an efficient dust exhaust system is provided. A cast iron guard ring is fastened to the top of the base with collar head screws and any portion of the guard ring is removable, permitting the grinding of work carrying a lug projecting above the plane of the ground surface. The machine is adapted to a large variety of flat surface operations. It is provided with Gardner improved abrasive discs, a new type of abrasive structure reported to cut twice as fast as the old time glue bond circles, and to last from six to twenty times as long. They are recommended for use on the No. 24 continuous feed machine and increase its efficiency to a marked extent.

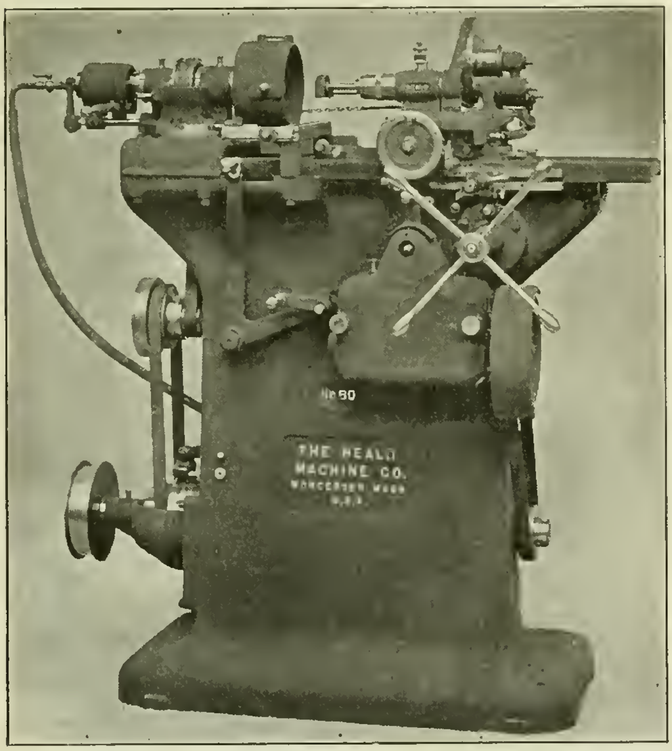


Method of Mounting Work Preliminary to Grinding

Power Feed Internal Grinding Machine

Careful design and building of the style No. 80 internal grinder by the Heald Machine Company, Worcester, Mass., have produced a relatively massive, rugged machine for precision grinding of small work. It is modeled on the lines of the successful style No. 85 internal grinder, having all its mechanical features and, in addition, an automatic feed for the table, which is desirable for work of small diameter and longer than 1½ in. A unique feature of this machine is the vertical pinion for driving the table, which is equipped with a double friction. If only the hand feed for the table is required, throwing in the upper friction engages the pilot wheel, disconnecting the power feed, which is controlled by the lower friction, and the machine becomes suitable for production work on small, short holes.

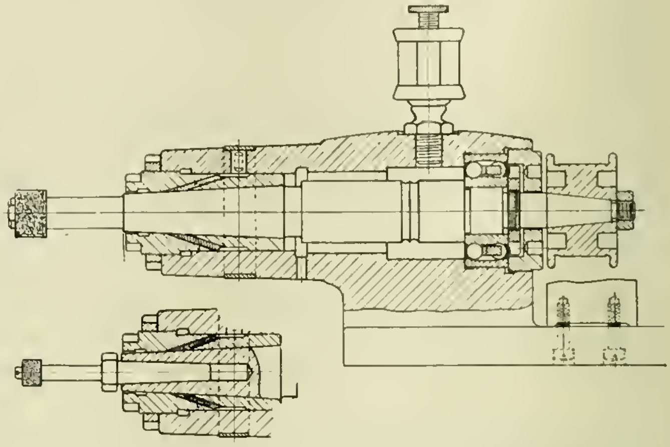
Ordinarily, while the wheel is actually grinding, the power feed is used, but as the wheel leaves the work the operator, by pulling the vertical lever at the head end, disconnects the clutch operating the power feed to the table and engages one connecting the hand feed, allowing rapid hand movement of the wheel-head table out of the way. At the same time, automatically, a guard swings over the wheel, the water and work stop, making plugging or removal of the work instantly possible. The machine can be used to grind holes ranging from ¼ in. to 2 in. in diameter up to a maximum length of 3¾ in. The actual swing inside the water guard is 6 in., while without the guard, it is 10 in. The work-head is driven by a cross belt through the base from a cone giving three speeds of 160, 290 and 530 r.p.m. It is arranged to swivel and is graduated to 45 deg. or 4 in. taper per foot. The rotation of the work head and the pump is automatically and quickly stopped as the grinding wheel is drawn from the work.



Heald No. 80 Power Feed Internal Grinder

The feed to the cross slide is calibrated to read to one-half thousandth of an inch on the diameter of the work. This can be operated by power or hand as desired. The main table has flat and V ways and is very rugged for this size machine. The travel of the table can be either by power, reversing accurately at any point desired or by hand feed with the power thrown out entirely. A two-step cone drive gives two speeds of travel with the power feed. The wheel head has a solid adjustable taper bearing at the wheel end with ball bearings at the pulley end.

Various holding fixtures have been designed and can be furnished on order. The one usually supplied and giving the largest range consists of a quick acting collet chuck with jaws, having a capacity of ⅜ in. diameter up to 3 in. This is operated by a lever with an adjustable compensating device which prevents the work from being distorted from pressure. In railway machine shops, the Heald No. 80 internal grinder would be of particular value for such work as grinding hardened motion work bushings made in quantity to be carried in stock and later fitted to valve motion levers.



Cross Section Through Wheel Spindle

Fundamental Principles of Handling Men

In a talk to foremen published in Industrial Management, George D. Halsey lays down the following principles as requisite for securing best results in handling men:

1. Delegate and supervise the work.
2. Keep compensation fair and strictly proportional to output or general value to the company.
3. Study each individual carefully and fit the method of handling to the individual.
4. Make a careful sub-division of all duties based on a study of individual abilities.
5. Prepare careful and, wherever possible, written instructions showing just how each job should be done, and fair time in which to do it.
6. Plan and schedule your work carefully and always let the workmen see plenty of work ahead.
7. Co-operate with and use staff aids as much as possible.
8. Maintain proper dignity.
9. Endeavor, whenever possible without intruding, to lead your employees into habits of right and sound thinking and clean living.
10. Cultivate in yourself a real and unselfish desire to be of help to your employees.

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WE GUARANTEE that of this issue 10,200 copies were printed; that of the 10,200 copies, 9,240 were mailed to regular paid subscribers, 8 were provided for counter and news company sales, 260 were mailed to advertisers, 32 were mailed to employees and correspondents, and 660 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 10,200, an average of 10,200 copies a month.

The *Railway Mechanical Engineer* is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

The shops of the Southern Pacific at Houston, Tex.—the paint shop, air brake shop, storehouse and office—together with a number of cars, were badly damaged by fire on December 7. Estimated loss $350,000.

In the annual inspection of the Pere Marquette, Charles Montgomery, master mechanic at St. Thomas, Ontario, was awarded the prize of $100 offered by the railroad to the officer showing the highest grade on condition of shop, shop grounds, repair tracks and engine houses.

In order that the names of the American Railway Master Mechanics' Association and the Master Car Builders' Association, the two organizations now comprising the mechanical division of the American Railway Association, may be perpetuated, both are now being included on the circulars and other publications of the mechanical division. The names "Master Car Builders" and "Master Mechanics" appear directly under the formal name of the organization.

Since the introduction of welded steel pipe, the term "wrought pipe" has been used indiscriminately to denote both welded wrought iron and welded steel pipe. This has led to confusion as the average consumer of pipe is not familiar with the manufacturing processes. In order to avoid this confusion, the National Pipe & Supplies Association has recommended that the terms employed by the American Society for Testing Materials in differentiating between iron and steel pipe, viz., welded wrought iron pipe and welded steel pipe, should be accepted and adhered to.

Two of Chicago's leading technical institutes, with the cooperation of the American Society for Steel Treating, will offer evening courses in the subjects of forging and heat treatment of steel. These courses are specially planned for the benefit of the practical men in the forge shop or heat treating departments or those who wish to qualify for such work. The course will embrace the following phases of the work: pyrometer, microscope, forging, annealing, alloy steels (dealing with the effects of different alloys and treatments upon the physical characteristics of steel), hardening and drawing of tool steel and case hardening. The plan and formation of this course was carried out by the Chicago chapter of the society through their educational committee and its seven sub-committees. The texts, lectures and demonstrations were prepared voluntarily.

The Southern Pacific has just completed a motion picture depicting graphically the story of oil, tracing its history from production to consumption. The film will be shown at all terminals and at principal points of the system as an aid in teaching the conservation of this product, of which the Southern Pacific uses 60,000,000 gallons a month, or about 16 per cent of all oil produced in California. The company, in notifying its employees of the picture, states that there is a message to be learned by all who see this film. Further, that the fuel industry faces a crisis; that those who depend upon the industry must take heroic measures if they would stave off disaster and that the picture shows what these measures are. It is further stated that the consumption of fuel oil now exceeds production by 30,000 barrels a day and reserve stocks in California are being depleted by 1,000,000 barrels a month.

Freight Car Orders

The Louisville & Nashville has ordered 1,500 steel hopper cars of 55 tons capacity from the American Car & Foundry Company and 500 from the Mt. Vernon Car Manufacturing Company.

Locomotive Orders

The Missouri Pacific has ordered 50 locomotives from the American Locomotive Company, divided as follows: 25 Mikados, 5 Pacifics, 5 mountain type and 15 switchers.

The Rio Grande do Sul State Railway (Brazil) has ordered 20 Mikado type locomotives from the American Locomotive Company. These locomotives will have 16 by 22 in. cylinders and a total weight in working order of 110,000 lb. and will be equipped with superheaters.

The Missouri Pacific has ordered 15 switching, 5 Mountain type and 5 Pacific type locomotives from the American Locomotive Company. The switching locomotives will have 6 wheels, and cylinders 21 by 28 in., and a total weight in working order of 165,000 lb.; the Mountain type locomotives will have 27 in. by 30 in. cylinders, and a total weight in working order of 345,000 lb.; the Pacific type locomotives will have 26 by 26 in. cylinders, and a total weight in working order of 265,000 lb. All these locomotives will be equipped with superheaters.

Union Pacific Develops New Safety Organization

As a means of spreading the gospel of safe practice to all of its employees most effectively, the Union Pacific has reorganized its safety department. Heretofore this has consisted of a general safety agent, with three assistants, all of whom had concurrent jurisdiction, and also three mechanical safety inspectors located in the large shops. In place of this organization there is now a general safety agent with five division safety agents and two shop safety inspectors. One division safety agent is assigned to each of the larger divisions, with one agent covering two divisions of lighter traffic. The two safety inspectors are assigned to the two larger shops, respectively, where they will supervise all operations, with a view to promoting safety, and also give safety lectures to each employee taken into the force before he is permitted to go on duty.

Another innovation covering the entire Union Pacific System, including the Union Pacific Railroad, the Oregon Short Line and the Oregon-Washington Railroad & Navigation Company, is a safety banner contest to be carried on for a period of one year, at the end of which time banners will be awarded on the basis of safety records made under the following conditions: (1) A banner to the system unit making the lowest record in casualties per one million locomotive miles. (2) A banner to one division on each system unit making the lowest casualty record per one million locomotive miles. (3) A banner to the one of the six large shops on the system, *i.e.*, Omaha, Kansas City, Denver, Cheyenne, Pocatello and Portland, making the lowest casualty record per 100 employees. Employees of the St. Joseph & Grand Island Railroad, which is a part of the Central Division of the Union Pacific, will be included in this contest. These banners will be awarded for a period of one year and at the end of the year following if another system unit or division on a system unit or one of the large shops on the system has made a better record in safety than that holding the banner for the preceding year, it will then be entitled to the banner for the ensuing year. It is expected that keen competition will be developed to win these banners and the result of this campaign is looked forward to with interest by the officers and employees of the Union Pacific System.

Mechanical Associations' Plan for Joint Exhibit

At a meeting of the official representatives of a number of minor railway mechanical associations and the associations of supply men exhibiting at the conventions of the railroad organizations, schedules were arranged for holding the conventions of a number of the associations at the Hotel Sherman, Chicago, during a continuous period of two weeks beginning September 6, 1921. The railroad organizations definitely committed to the plan are the Traveling Engineers' Association, the International Railway General Foremen's Association, the American Railroad Master Tinners', Coppersmiths' and Pipe Fitters' Association and the Chief Interchange Car Inspectors' and Car Foremen's Association. Others may possibly be included at a later date.

In order to carry out the details of the plan for conducting a continuous joint exhibit and to arrange for simultaneous meetings of some of the associations, a resolution was passed that a committee be organized consisting of a representative from each of the railway and supply associations interested, to take care of features of the arrangements which would not regularly be handled by the individual associations, and that this committee be prepared to present a report at a joint meeting to be held in September, 1921, recommending the form of a permanent joint organization, if such an organization seems to be desirable.

Shop Construction

Atchison, Topeka & Santa Fe.—This company is constructing 10 additional stalls at its enginehouse at Amarillo, Tex., each stall to be 120 ft. long. The company is also lengthening 12 of the present engine stalls from 92 to 102 ft. The construction is of concrete and will cost approximately $125,000.

Chesapeake & Ohio.—This company will add 10 stalls to its engine house, install a new turntable, and erect an ice plant, storeroom and office building at Clifton Forge, Va., at an approximate cost of $600,000.

Chicago, Indianapolis & Louisville.—This company has awarded a contract for the construction of car repair shops at Lafayette, Ind., to A. E. Kemmer, Lafayette. The structure, which will have dimensions of 85 ft. by 440 ft., will be of brick and steel construction and will cost approximately $140,000.

Denver & Salt Lake.—This company is rebuilding its shops at Utah Junction, Colo., which were destroyed by fire, at a loss of $250,000.

Missouri, Kansas & Texas.—This company has awarded a contract to H. D. McCoy, Cleburne, Tex., for the construction of a roundhouse, shop, storehouse, and roundhouse foreman's office at Oklahoma City, Okla. The company contemplates enlarging its roundhouse and car facilities at Osage, Okla.

Norfolk & Western.—This company is adding 16 stalls to its 24-stall engine house at West Roanoke, Va. The company is also adding 8 stalls to its engine house at Bristol, Va.

Land Slide Covers Pennsylvania Tracks at Pittsburgh

The operation of the Pennsylvania Railroad was seriously hampered during the month of November by a slide which for a time threatened to cover all the main line tracks. The failure of the retaining wall east of the Union Station allowed material which had been filled into a gulley to slide onto the tracks. The movement of the earth was gradual and measures were taken to excavate the material as fast as it slid onto the tracks. Eventually 9 large steam shovels, 2 small ditching machines, 120 40-yd. steel dump cars, 300 12- and 16-yd. wooden dump cars and about 500 gondola cars were used to keep back the slide. The maximum encroachment of the slide onto the railroad property occurred on November 22, when the toe of the slide extended 200 ft. from the mouth of the ravine. The main tracks were again placed in service on December 6.

Subjects for 1921 Convention—Traveling Engineers' Association

The list of subjects of committee reports to be presented at the 1921 annual meeting of the Traveling Engineers' Association, which has recently been issued, includes the following topics:

The Best Method of Operating Stoker Fired Locomotives to Obtain the Greatest Efficiency at the Least Expense; Joseph Kelley (L. V.), Chairman.
A Comprehensive Standard Method of Employing, Educating and Examining Engineers and Firemen; J. B. Hurley (Wabash), Chairman.
What Are the Advantages of the Self-Adjusting Wedges, the Feed Water Heater and Devices for Increasing the Tractive Power of the Locomotive in Starting and at Slow Speed; T. F. Howley (Erie), Chairman.
Subjects for Discussion: J. H. DeSalis (N. Y. C.), Chairman.
Distribution of Power and Its Effect on Operating Costs; Robert Collett (N. Y. C.), Chairman.
Recommended Practice for Conservation of Locomotive Appurtenances and Supplies; J. P. Russell (Southern), Chairman.

Railroad Wages in Need of Reform

Hon. George W. Anderson, of Massachusetts, judge in the United States District Court and former Interstate Commerce Commissioner, in a speech at Boston on Monday, November 29, denounced the present system of railroad wage rates as absurd and unjust, and called upon all interested to work for its correction. Speaking before a conference of commercial and railroad interests, called to take action to induce the Interstate Commerce Commission to "save the railroads and industries from ruination," threatened by the present financial condition of the roads, he condemned in strong terms "the absurd scheme of paying the same scale of wages all over the country, regardless of living conditions and of the amount of work required, to all men holding a job carrying the same name." He urged that inflexible standards of wages be abandoned, in the interests of the working men themselves, and characterized as absurd the labor unions' proposal to secure a standardization of working conditions. Labor must alter its policy in this matter, or the public must compel the Railroad Labor Board to alter it. It is a menace to the public interest.

The artificial standardization of wages, on a mere money basis, that is, regardless of money purchasing power in various sections and of the quantity and quality of service required of such employees as station agents and freight handlers in large overworked sections, as compared with the necessary labor at small stations in which the business is limited to two or three hours a day, cannot be justified.

Transportation of Explosives During 1918

During the year 1907, which immedately preceded the enactment of the act to promote the safe transportation in interstate commerce of explosives and other dangerous articles, etc., 79 accidents in the transportation of explosives resulted in 52 deaths, 80 personal injuries and a total known property loss of nearly $500,000. During the year 1918 our military program required the production and transportation of more than 2,000,000,000 pounds of military explosives. In addition to this, the normal movement of explosives for commercial use amounted to about 600,000,000 pounds. It is deduced from careful estimates that at all times during the year 1918 there were on the tracks of the railroads in the United States not less than 55,000 carloads of explosives of an average weight of 40,000 pounds each. Notwithstanding the tremendous increase in the volume of these explosives transported during that year, the casualties resulting therefrom were only two persons injured and the damage to property was about $33,000.

In the transportation of dangerous articles other than explosives, however, 1,204 accidents occurred during 1918, resulting in 17 persons killed, 86 persons injured, and a known property loss of approximately $1,300,000. The remarkable success in transporting explosives is attributed to the penal provisions of the act of March 4, 1909, and the enforcement thereunder of our regulations governing such transportation. —From the Annual Report of the Interstate Commerce Commission.

MEETINGS AND CONVENTIONS

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

Division V.—Equipment Painting Division.—V. R. Hawthorne, Chicago.

American Railway Association, Division VI.—Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamlin Ave., Chicago.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Society for Steel Treating.—W. H. Eisenman, 154 E. Erie St., Chicago.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Meeting second Tuesday in each month except June, July and August, at Windsor Hotel, Montreal, Que.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago. Meeting second Monday in month, except June, July and August, New Morrison Hotel, Chicago.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

Central Railway Club.—H. D. Vought, 95 Liberty St., New York. Next meeting January 14. Film pictures of Baldwin Eddystone plant will be shown and an explanatory address given by A. H. Ehle, general sales manager.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Meetings second Tuesday in February, May, September and November, Hotel Sinton, Cincinnati, Ohio.

Dixie Air Brake Club.—E. F. O'Connor, 10 West Grace St., Richmond, Va.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 715 Clarke Ave., Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East 51st St., Chicago.

International Railway General Foremen's Association.—William Hall, 1061 W Wabasha Ave., Winona, Minn.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York. Convention May 23 to 26, 1921, inclusive, Planters' Hotel, St. Louis, Mo.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting, January 11. Paper on the Service of Supply will be presented by H. C. Pearce, general purchasing agent, Seaboard Air Line.

New York Railroad Club.—H. D. Vought, 95 Liberty St., New York.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Building, Buffalo, N. Y. Regular meetings January, March, May, September and October.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Meetings second Thursday in month, alternately in San Francisco and Oakland, Cal.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Meetings fourth Thursday in month except June, July and August, American Club House, Pittsburgh.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Meetings second Friday in month except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Buffalo, N. Y.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard. Next meeting January 17, 1921. Paper on Cause of the Present Condition of Freight Cars and Suggestions for Their Improvement will be presented by J. C. Fritts, master car builder, D. L. & W.

PERSONAL MENTION

GENERAL

H. B. Smith has been appointed fuel agent of the Kansas City Southern, with headquarters at Kansas City, Mo., succeeding B. B. Brain, who has been promoted to purchasing agent.

H. L. Worman

H. L. Worman, assistant superintendent of motive power of the St. Louis-San Francisco, has been appointed superintendent of motive power, with headquarters at Springfield, Mo., succeeding C. C. Higgins, deceased. Mr. Worman was born at Salem, Ohio, July 19, 1877. He entered the service of the St. Louis-San Francisco in 1905 as a machinist in the shops at Kansas City, Mo. In 1906 Mr. Worman was appointed roundhouse foreman at Kansas City. In 1907 he became erecting foreman and in 1908 machine foreman in the same shop. In 1911 he was appointed general foreman at Fort Scott, Kan., and in 1916 he became traveling roundhouse foreman for the entire system. In 1917 he was appointed master mechanic at Memphis, Tenn. In 1919 he was appointed assistant superintendent of motive power, with headquarters at Springfield, Mo., which position he held at the time of his recent promotion.

Eugene R. Gorman

Eugene R. Gorman, superintendent of motive power and machinery of the Chicago, St. Paul, Minneapolis & Omaha, with headquarters at St. Paul, Minn., was born on December 3, 1879, at Gorman Town, Minn. He entered railway service in April, 1900, as a locomotive fireman on the Chippewa Valley & Northern, a road owned and operated by the Arpin Hardwood Lumber Company, Bruce, Wis. In September, 1901, he became a locomotive fireman on the Western division of the Chicago, St. Paul, Minneapolis & Omaha. He was promoted to engineman and transferred to the Northern division in February, 1907, but left the company's service in May, 1908, to go with the Northern Pacific, working out of Missoula, Mont. In May, 1912, Mr. Gorman was appointed traveling engineer on the Northern division of the Chicago, St. Paul, Minneapolis & Omaha, with headquarters at Spooner, Wis., and served in this position until December, 1915, when he was promoted to trainmaster on the same division. In May, 1917, he was made acting assistant superintendent of the Western division, with headquarters at St. James, Minn., this temporary promotion being made permanent in November, 1917. At the time of his recent promotion, Mr. Gorman was assistant superintendent of the Eastern division, with headquarters at Eau Claire, Wis., where he had been transferred in April, 1919.

Alfred A. Klein has been appointed lubrication supervisor of the Santa Fe at Richmond, Cal., and will be directly under C. T. Ripley, general mechanical supervisor. Mr. Klein is one of the Santa Fe machinist apprentices graduated several years ago at the Topeka shops and has served in various capacities. During the last two years he was apprentice school instructor at Richmond.

Captain H. P. M. Beames has been appointed chief mechanical engineer of the Crewe Works and the hydraulic department of the London & North Western Railway, with offices at Crewe, England, succeeding C. J. Bowen Cooke, deceased. Captain Beames entered the Crewe Works as an apprentice in January, 1895, and, after his elementary training, held numerous positions of responsibility in the chief mechanical engineer's department, becoming locomotive works manager in April, 1916. At the outbreak of the South African war, he volunteered and served as a private, later becoming a sergeant. When the European war broke out, he again volunteered for military service and was given a command in the Royal Engineers, returning later to his position at the Crewe Works.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

W. A. George was appointed master mechanic of the Jacksonville Terminal, effective December 10.

H. G. Bonney has been appointed assistant master mechanic of the Lehigh & New England, with headquarters at Pen Argyl, Pa., succeeding N. R. Wright, resigned.

L. C. Tyler has been appointed road foreman of engines of the Cleveland, Cincinnati, Chicago & St. Louis, with headquarters at Urbana, Ill., succeeding Charles McCarty, transferred.

H. C. Gillispie, master mechanic of the Chesapeake & Ohio, with headquarters at Peru, Ind., has been transferred to a similar position at Huntington, W. Va., succeeding W. S. Butler, promoted. E. R. Woody, assistant master mechanic at Fulton, Va., succeeds Mr. Gillispie as master mechanic at Peru.

J. W. Lemon, master mechanic on the Central Kansas division of the Missouri Pacific, with headquarters at Osawatomie, Kan., has been transferred to the Colorado division, with headquarters at Hoisington, Kan., effective December 15. S. L. Landis has been appointed acting master mechanic succeeding Mr. Lemon.

W. M. Green has been appointed road foreman of engines of the Big Sandy division of the Chesapeake & Ohio, with headquarters at Paintsville, Ky., succeeding D. S. Baals, resigned. W. A. Mordica has been appointed road foreman of engines and assistant trainmaster, Shelby coal district, with headquarters at Shelby, Ky.

CAR DEPARTMENT

F. O. Erickson has been appointed car foreman of the Chicago, Rock Island & Pacific at Manly, Ia., succeeding M. B. Flaherty, who has been transferred.

J. W. Johnston, chief inspector of car lighting of the Canadian National, with headquarters at Toronto, has had his jurisdiction extended to include the Grand Trunk Pacific.

J. Gutteridge, foreman of the car department of the Kansas City Southern at Pittsburg, Kan., has been appointed general foreman, car department, with headquarters at Pittsburg, with jurisdiction over the entire line. C. E. Oakes has been appointed shop superintendent at Pittsburg, succeeding William Turley, resigned.

SHOP AND ENGINEHOUSE

L. E. Fletcher, master mechanic on the Atchison, Topeka & Santa Fe, with headquarters at La Junta, Colo., has been promoted to superintendent of shops, with the same headquarters. G. M. Lawler succeeds Mr. Fletcher.

Francis P. Howell, whose appointment as shop superintendent of the Atlantic Coast Line at Waycross, Ga., was announced in the December issue, was born on October 11, 1876, at Tarboro, N. C. He received a high school education and entered the employ of the Atlantic Coast Line on April 11, 1896, at Rocky Mount, N. C., as a machinist apprentice. In April, 1902, he was promoted to night roundhouse foreman; in May, 1903, appointed gang foreman; and in March, 1908, promoted to erecting shop foreman. In January, 1909, he was transferred as erecting shop foreman to Waycross, and in July, 1917, was promoted to general foreman. In July, 1918, he became master mechanic, with headquarters at Savannah, Ga., which position he held at the time of his recent appointment.

Clarence W. Adams, whose appointment as shop superintendent on the Michigan Central at Jackson, Mich., was announced in the December *Railway Mechanical Engineer,* was born on March 17, 1885, at St. Thomas, Ont. He attended the Collegiate Institute and entered the service of the Michigan Central on September 1, 1902, as a machinist apprentice. After finishing his apprenticeship in 1906, he was employed by the Pere Marquette, and also by the Burroughs Adding Machine Company, Detroit. In October, 1907, he returned to the Michigan Central at St. Thomas as a machinist. In 1912, he was promoted to gang foreman and erecting foreman; in 1916, enginehouse foreman; and finally, general foreman of shops and enginehouse, which position he held at the time of his recent appointment.

PURCHASING AND STOREKEEPING

J. B. Fowler has been appointed division storekeeper on the Pennsylvania, with headquarters at Fort Wayne, Ind.

H. W. Concannon has been appointed division storekeeper of the Salt Lake division of the Southern Pacific, with headquarters at Ogden, Utah, succeeding S. J. DeGraff, assigned to other duties.

F. Osterman, chief clerk of the purchasing department of the Chicago Great Western, has been appointed assistant purchasing agent of the Pere Marquette, with headquarters at Detroit, Mich.

L. Lavoie, assistant general purchasing agent of the Canadian National, with headquarters at Toronto, has been appointed general purchasing agent, with the same headquarters, succeeding E. Laugham, who is retiring from active service.

H. P. Buchenery, assistant division storekeeper of the Southern Pacific, with headquarters at Sparks, Nev., has been promoted to division storekeeper, with headquarters at Tracy, Cal., succeeding V. R. Taylor, transferred to Tucson, Ariz. J. F. McAuley succeeds Mr. Buchenery.

B. B. Brain, whose appointment as purchasing agent of the Kansas City Southern was noted in the December issue, entered railway service in 1885 with the Kansas City, Fort Scott & Memphis (now a part of the St. Louis-San Francisco). In 1902 he went to the Kansas City Southern as general storekeeper, with headquarters at Kansas City. Later he served as chief clerk in the purchasing department and, since 1912, has been fuel agent for the company, which position he held at the time of his recent appointment.

G. W. Bichlmeir, purchasing agent of the Kansas City Southern, has been appointed purchasing assistant of the Union Pacific, with headquarters at Omaha, Nebr. Mr. Bichlmeir was born at Cincinnati, Ohio, September 10, 1886, and entered the employ of the Cincinnati, Hamilton & Dayton in 1906 as a clerk in the office of the purchasing agent. In 1909 he became a clerk in the department of supply of the Missouri Pacific at St. Louis, Mo., and the following year was appointed chief clerk to the division storekeeper at Osawatomie, Kan., where he remained until January, 1911, when he became chief clerk to the general storekeeper of the Kansas City Southern. He remained in this position until 1917, when he resigned to engage in business. In April, 1918, he again entered the employ of the Kansas City Southern as chief clerk to the purchasing agent, and in August of the same year was appointed assistant to the purchasing agent. Mr. Bichlmeir was appointed purchasing agent of the Kansas City Southern in March, 1920, and was holding that position at the time of his recent appointment.

OBITUARY

C. J. Bowen Cooke, chief mechanical engineer of the London & North Western, died October 19. Mr. Bowen Cooke entered the Crewe works of the London & North Western as a premium apprentice in February, 1875, and in 1880 was appointed assistant to the superintendent of the running department for the southern division. In 1899, when the running departments of the London & North Western were put under one jurisdiction, he became assistant superintendent for the southern division, which position he held until June, 1909, when he was appointed chief mechanical engineer.

ROBERT SPEER MILLER, master car builder of the New York, Chicago & St. Louis, died suddenly of heart failure at his home at Cleveland, Ohio, December 1. Mr. Miller was born in Washington county, Pennsylvania, September 13, 1856. He entered railway service in 1879 with the Pittsburgh, Cincinnati, Chicago & St. Louis as a rodman in the engineering department. In 1882 he entered the service of the New York, Chicago & St. Louis, and subsequently served as foreman, general car inspector and master car builder of the same road, which latter position he held at the time of his death.

H. J. SMALL, for many years general superintendent of motive power and machinery of the Southern Pacific, died October 28, at Berkeley, Cal. Mr. Small was born at Cobourg, Ont., November 15, 1849, and was educated at Toronto Normal School. He entered railway service in 1868 as a machinist on the Chicago North Western. A year later he became a draughtsman for the Kansas Pacific (now a part of the Union Pacific), which position he resigned in 1871 to become chief draughtsman for the Northern Pacific. In 1873 he went to Texas to become a general foreman on the International & Great Northern, which position he held until 1877, when he became master mechanic for the Galveston, Houston & Henderson. He left this position in 1879 to become master mechanic on the Texas & Pacific. In 1881 he was appointed superintendent of machinery of the Northern Pacific, and in 1887, assistant superintendent of motive power of the Philadelphia & Reading. Mr. Small became superintendent of motive power and machinery of the Southern Pacific in 1888, and, in 1902, was appointed general superintendent of motive power and machinery. He remained in this position until 1915, when he retired on account of ill-health.


H. J. Small

Railway Accidents in the United Kingdom During 1919

The Ministry of Transport recently issued a report on the accidents which occurred on the railways of the United Kingdom in 1919. There was a total of 932 people killed, as against 870 in 1918, while the number of persons injured last year totaled 23,983. Of accidents in which the movement of trains and railway vehicles was not concerned, only the fatal cases were required to be reported in 1918, so that a comparison under that head is not possible. The number of killed in 1919 included 361 trespassers—comprising suicides—and 318 servants of companies or contractors met their deaths by accidents in which the movement of trains was concerned. There were 827 persons killed and 5,897 injured during the year in accidents caused by the movement of trains and railway vehicles (exclusive of train accidents). Twenty-seven passengers were killed and 810 injured by falling between trains and platforms or on to platforms, ballast, etc., when attempting to enter or alight from trains, nine were killed and 13 injured when crossing lines at stations, 28 were killed and 76 injured by falling out of carriages during the running of trains, and 10 were killed and 927 injured from other causes.

There were 28 collisions during 1919, and of a total of 30 cases of train accident 10 were ascribed to the failure of enginemen to obey danger signals.

SUPPLY TRADE NOTES

George Baker, formerly general sales manager for the Illinois Steel Company, Chicago, who retired from active service about two years ago, died on November 18.

The General Railway Devices Company has been organized at Racine, Wis., with W. H. Osborne, president, John G. Osborne, vice-president, and W. V. Osborne, secretary and treasurer.

James C. Carlton, formerly connected with the Thompson Machinery Company, Pittsburgh, Pa., has entered the employ of the sales department of the Sherritt & Stoer Company, Philadelphia.

P. V. Burwell, who has been acting as an assistant for the advertising manager of the Black & Decker Manufacturing Company, Baltimore, Md., has been appointed assistant advertising manager.

The Air Reduction Sales Company, New York, has just completed building a four-story addition to its apparatus plant, Jersey City, N. J. It is of brick construction with reinforced concrete floors.

Edward Buker has been appointed representative of the car seat department of the Heywood Brothers & Wakefield Company, Wakefield, Mass., with office and exhibits at 1415 Michigan avenue, Chicago.

The Bastian-Blessing Company, Chicago, Ill., manufacturer of Rego oxy-acetylene and oxy-hydrogen products, has appointed the Beck-Hill Corporation, 22 Thames street, New York, as its sole eastern railway representative.

C. A. Eggert, who was for a number of years connected with the sales department of the Consolidated Car Heating Company, Albany, N. Y., has entered the employ of the O. M. Edwards Company, Inc., as sales manager, at 1425 Edison building, Chicago, Ill.

C. B. Merrell, who has been for a number of years in the general offices of the Economy Fuse & Manufacturing Company, Chicago, has been appointed district sales manager of its Philadelphia office, 523 Widener building, vice E. J. Watson, resigned.

J. C. Kopf, formerly manager of the engineering department of the Duff Manufacturing Company, has been appointed research engineer and placed in charge of a newly established research department. F. W. Schwerin has been promoted to manager of engineering.

A report has been published in some trade papers that the operation of the foundry of the Modern Steel Casting Company, Milwaukee, Wis., had been suspended because of a fire. The company states that this report is not true, as the damage was slight and the foundry is running at normal capacity.

A. E. Smith has been elected a vice-president of the Union Tank Car Company in charge of the construction and maintenance of plant and equipment. Mr. Smith will handle all correspondence regarding repairs to cars and M. C. B. matters. The office of master car builder has been discontinued.

The consolidation of the Whiting Foundry Equipment Company, of Harvey, Ill., and the American Foundry Equipment Company, of New York, as announced in the October issue, has not been consummated, and the two companies will continue to operate as separate concerns the same as heretofore.

H. G. Keller, manager of the Philadelphia, Pa., office of the Independent Pneumatic Tool Company, Chicago, has been promoted to manager of the New York office and F. H. Charbono, manager at St. Louis, Mo., has been promoted to manager of the Philadelphia office to succeed Mr. Keller.

P. C. Cady, who was for several years with the mechanical engineering department of the New York Central, has opened an office at 133 Greenwich street, New York, and will represent the following concerns: Guilford S. Wood Company, Chicago; J. Faessler Manufacturing Company, Moberly, Mo.; Coale Muffler

& Safety Valve Company, Baltimore, Md.; W. C. Dunn Company, Cincinnati, Ohio, and the Virginia Equipment Company, Oak Harbor, Ohio.

Ethan Viall, who for ten years served as an editor on the staff of the American Machinist, has resigned to take over the management of a middle-western manufacturing plant in which he has been interested. Mr. Viall's place has been taken by H. K. Condit, the former managing editor, and L. C. Morrow succeeds Mr. Condit.

The Falls Rivet Company, Kent, Ohio, has bought from the Ohio Wire Goods Manufacturing Company, Akron, Ohio, all its machinery, patents and patterns relating to the manufacturing of cotter pins and flat spring keys. The machinery has been moved from Akron to Kent and is now in operation. Lawrence Kneifel, of the organization at Kent, has become associated with the Falls Rivet Company.

Bruce Hartman, of Bloomsburg, Pa., a director of the Bell Locomotive Works, has been appointed receiver of the company by Federal Judge Witmer at Sunbury, Pa. The company's office is at 23 Water street, New York, and its works are at Bloomsburg. J. S. McCormack, sales manager, and William Stevenson, chief engineer, in the New York office, will probably remain with the company under the receiver.

Richard Sanderson, manager of the New York office of the Baldwin Locomotive Works and the Standard Steel Works Company, Philadelphia, Pa., has been transferred to Philadelphia as vice-president in charge of sales of the Standard Steel Works Company, succeeding Robert Radford, resigned. Mr. Sanderson was born on July 30, 1888, at Lynchburg, Va., and was educated at Worcester Polytechnic Institute, leaving there in 1910. He started as an apprentice on the Seaboard Air Line, later finishing his apprenticeship at the Baldwin Locomotive works. In 1912 he entered the New York office as assistant representative of the sales department for both the Baldwin Locomotive Works and the Standard Steel Works Company, remaining in that capacity until April 1, 1919, when he was made manager of the New York office for both companies. On December 1 he was elected vice- president of the Standard Steel Works Company, as above noted.

R. Sanderson

The Chicago Pneumatic Tool Company announces the appointment of J. F. Huvane as eastern manager of compressor and engine sales, with headquarters at 6 East Forty-fourth street, New York, and G. C. VandenBoom as western manager of compressor and engine sales, with headquarters at 300 North Michigan boulevard, Chicago. H. L. Dean, formerly manager of the compressor and engine sales division, has resigned.

The following companies have been appointed representatives of the Pneumatic Safety Valve Company, Woonsocket, R. I.; Frank E. Harrison, 56 Pine street, New York; the R. C. Neal Corporation, 76 Pearl street, Buffalo, N. Y.; the Sixt & Day Company, Guardian building, Cleveland, Ohio; Midgley & Borrowdale, 1550 McCormick building, Chicago, Ill., and the Charles A. Dowd Sales Company, 320 Market street, San Francisco, Cal.

Mr. Pasley, metallurgist, and Mr. Clowes, a mill production man, of Samuel Osborn & Co., Ltd., Sheffield, England, who have been visiting various plants in the United States and Canada making a study of American conditions and requirements, have returned to England. Their visit followed that of Arnold Pye-Smith, the London director, who was here during the summer for about five weeks. B. M Jones & Co., Inc., is the American representative of Samuel Osborn & Co.

S. C. Wilson has been appointed sales engineer in the Pittsburgh, Pa., office, 1224 Fulton boulevard, of the Whiting Foundry Equipment Company, Harvey, Ill., succeeding C. H. Martin. Mr. Wilson for the past year and one-half has served at the main office and works of the company. J. D. James, who has been with the Whiting company for the past eleven years, serving in various capacities, has been appointed assistant to George F. Crivel, the company's representative at 430 Ellicott Square, Buffalo, N. Y.

The Dunbar Manufacturing Company announces that the corporate name of the firm has been changed to the Morton Manufacturing Company. H. U. Morton is president; H. H. Schroyer, vice-president, and Charles D. Morton, secretary and treasurer. The factory and general offices are situated at 5133-39 W. Lake street, Chicago, as formerly. Among the railway appliances handled by this company are vestibule diaphragms (canvas and steel), steel doors for passenger and baggage cars, Chanarch steel flooring, car window curtains and fixtures, curtain rollers, sash locks and racks.

Harry U. Morton

Harry U. Morton, president of the Morton Manufacturing Company, entered railway service with the Pullman Company in 1891. He served this company for 4 years in the manufacturing department, and 13 years in the operating department. In 1907, he was appointed vice-president and general manager of the General Railway Supply Company, and seven years later became vice-president and secretary of the Acme Supply Company, Chicago. The corporate name of this company was changed to the Dunbar Manufacturing Company in 1917, and on April 1 of that year Mr. Morton was elected president and treasurer of the company. Charles D. Morton is the son of H. U. Morton. He is a graduate of the University of Wisconsin, class of 1917. He entered service with the company immediately upon receiving his discharge from the army in January, 1919.

C. D. Morton

The Toledo Crane Company, with main office and works at Bucyrus, Ohio, chartered in Ohio, with a capital of $500,000, succeeds the Toledo Bridge & Crane Company, of Toledo, Ohio, as builders of Toledo cranes. The new company has bought all drawings, patterns, records, and every item pertaining to the crane business. W. F. Billingsley, who for the past 11 years has been active in the management of the crane department for the Toledo Bridge & Crane Company, holds an executive position and is active in the management of the new company and has with him intact the present crane department organization of the Toledo Bridge & Crane Company.

H. W. Jacques, for the past six years manager of the railway supply department of the Simmons Hardware Company, St. Louis, Mo., has left the service of that company and has established an office at 404 Parkway building, Philadelphia, Pa. He will represent in the railroad field the following firms: Baldwin Tool Works, Parkersburg, W. Va.; Fayette R. Plumb, Inc., Philadelphia, Pa.; Columbus Handle & Tool Company, Columbus, Ind.; American Handle Company, Jonesboro, Ark.; Keller & Tamm Manufacturing Company, St. Louis, Mo.; Western Tinware Company, St. Louis, Mo.

James C. Currie, eastern representative of the Nathan Manufacturing Company, New York, was killed in an elevator accident in New York City on December 11. Mr. Currie was born in Scotland 69 years ago and came to the United States when he was 12 years of age. Shortly afterwards he entered the service of the Pennsylvania Railroad as a fireman and later served as engineman on the Congressional Limited. About 26 years ago he went to the Nathan Manufacturing Company as its eastern representative and was with that firm until his death. Mr. Currie was well known in the railway supply field and was assistant grand chief of the Brotherhood of Locomotive Engineers.

Don L. Clement will again represent Pratt & Lambert, Inc., Buffalo, N. Y., in the railroad field, with headquarters in New York. Mr. Clement represented Pratt & Lambert, Inc., in a like capacity until November, 1917, when he was commissioned in the Engineer Corps of the United States Army, and was immediately assigned to the 35th Engineers, a unit organized for the purpose of erecting railroad cars in France. He was overseas 16 months, and during the greater part of this time was assistant adjutant and adjutant of the 35th Engineers, which eventually became one of the grand divisions of the Transportation Corps. He was discharged in May, 1919, with the rank of captain. Since Mr. Clement's return to civilian life, he has been connected with Pratt & Lambert, Inc., on inside work of a special character.

The American Malleable Castings Association inaugurated a research program in 1915 to improve the works' practice of the member companies and insure a uniform high-grade product. The improvement in the properties of malleable iron, which has been brought about as a direct result of this policy, is set forth in a statement recently authorized by the association. Records of tests made in 1911 showed the average ultimate strength of malleable iron as manufactured to be about 39,000 lb. and the elongation under 5 per cent. A report made in September, 1920, showed an average ultimate strength of over 53,000 lb., and an average elongation of over 14 per cent. The report also showed that the result of this co-operative research work was not only to increase ultimate strength and elongation, but to increase the uniformity of the product.

Metal & Thermit Corporation

The Metal & Thermit Corporation has opened a branch office at 141 Milk street, Boston, Mass. Robert L. Browne is the New England district manager. O. E. Falls, who has had many years of experience in charge of foundry and thermit welding work at the Norfolk Navy Yard, Portsmouth, Va., has accepted a position with the Metal & Thermit Corporation, New York. Mr. Falls obtained his earlier foundry experience from positions held at the Norfolk & Western shops, Roanoke, Va.; the Richmond Locomotive Works, Richmond, Va.; the Pennsylvania Engineering Works, New Castle, Pa.; the Franklin Air Compressor Works, Franklin, Pa.; and the Seaboard Air Line shops, Portsmouth, Va. At the last mentioned company, Mr. Falls began his first thermit welding work. In 1905, he joined the Goldschmidt Thermit Company, New York, and in 1907, returned to the Norfolk Navy Yard and for ten years did all or supervised the thermit welding work of that company. In 1917, he became superintendent in the steel foundry of the Bay View Foundry Company, Sandusky, Ohio. Later he was appointed superintendent of the steel foundry of the Weatherley Steel Castings Company, Weatherley, Pa., and still later superintendent of the iron and brass foundry of the Gaskins Foundry Company, New Bern, N. C. When he accepted his present position with the Metal & Thermit Corporation, he was superintendent of the iron and brass foundry of the Manning Manufacturing Company, Rutland, Vt.

TRADE PUBLICATIONS

Handbook for Drillers.—A 37-page booklet has been designed for students of drilling by the Cleveland Twist Drill Company, Cleveland, Ohio. It is in reality a thoroughly revised, rewritten and reillustrated edition of "Uses and Abuses of Twist Drills."

Lifting Jacks.—The Duff Manufacturing Company, Pittsburgh, Pa., is distributing catalogue No. 104, a new 148-page book illustrating and describing the complete line of Duff lifting jacks. It includes jacks of all types for steam railway work—track jacks, car jacks, locomotive jacks, bridge jacks and journal box jacks.

Leather Belting.—The manufacture and renovation of leather belting are treated in Catalogue No. 12 of the Consolidated Belting Company, Philadelphia, Pa. A valuable feature of the catalogue is a concise discussion of belting problems and their solution and formulae for calculating the proper sizes and speeds for belts.

Lubrication.—Technical discussion of lubrication and the use of lubricating oils in various industries form the subjects of the articles in the monthly publication of the Texas Company, New York City. This magazine is distributed without cost to those who are especially interested in the use and selection of lubricants.

Thermit Welding.—An instruction book, especially prepared for use by men actually performing thermit welding repairs in railroad shops, has recently been issued by the Metal & Thermit Corporation, New York. This booklet, which is known as Pamphlet No. 41, is of convenient pocket size for ready reference.

Lathe and Planer Tools.—A 32-page catalogue has been issued recently by the Ready Tool Company, Bridgeport, Conn., showing the various kinds and sizes of tools manufactured by this company. These tools include high-speed lathe centers; lathe, grinder and milling-machine dogs; lathe and planer tools, hold-downs, and belt sticks.

Radial Drills.—The Western Machine Tool Works, Holland, Mich., has recently issued catalogue No. 21, in which its line of plain and universal radial drills is fully described and illustrated. The special feature of these drills is the low hung drive in which the spindle driving gear is located at the lower end of the spindle just above the socket.

Hoists.—The Wright Manufacturing Company of Lisbon, Ohio, manufacturers of high speed hoists, screws and differential blocks and steel trolleys, have issued an attractive new catalogue descriptive of their line. It contains much data of use to those interested in hoists and a portion of the catalogue is devoted to a discussion of the various types of hoists and the field of usefulness of each.

Instruction Book for Railroad Shops.—The Metal & Thermit Corporation, New York, has just issued a small Thermit railroad instruction book, No. 41, expressly prepared for use by men actually performing Thermit welding railroad repairs. The pamphlet is of a convenient pocket size and the instructions have been condensed into the smallest possible space consistent with clearness aand thoroughness.

Spanish Leaflet.—That the English-speaking race is not the only large user of thread-cutting machinery is indicated by the fact that the Landis Machine Company, Waynesboro, Pa., has issued recently a 16-page leaflet, in Spanish, describing Landis thread-cutting machinery. This leaflet is intended for distribution in Spain and South America and includes many illustrations of different types of machines, together with their descriptions, from the earliest days to the present time.

Reilly Feed Water Heater.—Bulletin No. 260 has been issued by the Griscom-Russell Company, New York, describing two types of Reilly feed water heaters. It is pointed out in the first part of the bulletin that the prime function of a boiler is to generate steam, not to heat water. Special emphasis is laid on the value of feed water heaters in saving fuel, increasing boiler capacity, reducing the cost of maintaining a boiler and increasing its life. A method of computing the actual saving resulting from the use of a feed water heater is given. Complete tables of dimensions for the different sizes of heaters are included in the bulletin. The proper methods of installing Reilly heaters are shown in detail, together with the information required when ordering.

Radius Tools.—The advantages of standard radius lathe and planer tools are plainly indicated in a little booklet issued recently by the R. G. Smith Tool & Manufacturing Company, Newark, N. J. Illustrations are included showing how convex or concave surfaces of any standard radius can be machined by the use of special cutters. A holder is provided for the cutter, which may be used almost indefinitely, as it can be reground many times without altering the cutting radius.

Rail Welding.—The Metal & Thermit Corporation, New York, has issued a new and revised Thermit rail welding pamphlet, No. 39, which describes the various ways in which Thermit welding can be advantageously used for rail welding, such as for eliminating rail joints and track maintenance expense in ordinary paved track, for making low cost and low maintenance frogs and crossings, for repairing motor cases and truck frames and for welding steam railroad rails in paved streets or where main highways cross the tracks.

Tubular Steel Poles.—Bulletin No. 14-C of the National Tube Company, Pittsburgh, Pa., is an attractive 48-page booklet which sets forth the advantages of tubular steel poles. The application of this type of support to high automatic or manual signals, trolley wires, telegraph and telephone lines, transmission lines and lighting fixtures, is illustrated and described. A tabulation of sizes, weights. etc., facilitates the selection of the pole best suited for the particular service. The closing pages of the bulletin are devoted to tables, giving the properties of steel pipe.

Carbonfree Metals.—The Metal & Thermit Corporation, New York, has issued the fourth edition of its Thermit Carbonfree Metals and Alloys Pamphlet No. 20. The pamphlet, in addition to containing a detailed description of the properties and characteristics of the various carbonefree metals and alloys manufactured by this company, includes also for the first time an explanation of the advantages of using tungtabs or tablets of pure tungsten metal in the production of high speed steel and other alloys containing tungsten instead of using tungsten powder and ferro-tungsten.

Wrought-iron Pipe.—Bulletin No. 1, issued recently by the Reading Iron Company, Reading, Pa., is a finely illustrated 31-page bulletin describing wrought-iron pipe, both in manufacture and service. An interesting account is given of the origin and development of the wrought-iron industry. Illustrations and descriptions are given of the various processes entering into the manufacture of wrought-iron pipe, including the puddling process, manufacture of the skelp, and the different operations in making the final product. The advantages of wrought-iron pipe over steel pipe are commented upon, and the last few pages of the bulletin show some interesting examples of the use of wrought-iron pipe.

Die Blocks.—Catalogue No. 3 entitled "Die Blocks" has been issued by the Pennsylvania Forge Company, Philadelphia, Pa. The catalogue explains that quality and uniformity should be the first consideration in ordering die blocks. The first cost of the steel is negligible compared with the expense of sinking and the risk of cracking in hardening. It is stated that die blocks made by this company are made of acid open hearth steel in 10-ton furnaces, insuring uniformity of product. A description of the various grades of die blocks is given in the catalogue, together with recommended heat treatment. A complete table of the weights of die blocks is shown; also a table of draft angles for die sinkers.

Skin Sores and Boils.—"Causes of Skin Sores and Boils Among Metal Workers" is the title of a 51-page booklet issued recently by E. F. Houghton & Co., Philadelphia, Pa. One of the serious problems confronting the metal-cutting industries is that of boils and skin sores among operators, and this booklet presents the results of a complete investigation of the subject made by the Houghton research staff. The work is thoroughly practical and shows that wherever the suggestions for prevention of infection have been applied in a common sense manner, the infection has been cut down and in some cases eliminated. The investigation also showed no grounds for the widespread belief that cutting compounds are primarily responsible for the various forms of infection among metal-cutting operators.

Industrial Relations Work of Westinghouse Air Brake Company.—An attractive illustrated book describing the agencies that have been established to promote the general well-being of the employees and to facilitate pleasant, harmonious industrial relations, has recently been issued by the Westinghouse Air Brake Company as publication 9044. The efforts of this company to cooperate with its employees have extended over more than a half century. At present the company has an Industrial Relationship Committee, a pension system, a relief department, a workmen's compensation fund, Y. M. C. A. and Y. W. C. A. buildings and other social activities. All these are outlined in a manner that makes the book valuable to anyone interested in the subject of relation between employer and employee.

Magnesia Pipe and Boiler Covers.—The field for heat insulating coverings for pipes and boilers is covered in a thorough manner in an attractive booklet entitled "Defend Your Steam" published by the Magnesia Association of America, Philadelphia. Numerous accounts of tests and extracts from technical papers are given to show the efficiency of magnesia as insulating material. The process of manufacture from Dolomite rock is described and descriptions and illustrations of typical installations are given. The book contains tables showing the losses from bare steam pipes and the saving in fuel and in money effected by the use of magnesia insulation. The specifications of the Magnesia Association are included and charts are shown from which the thickness of covering for the maximum net saving can be obtained.

Leather Belting.—Bulletin No. 101, entitled "Standardized Leather Belting," and containing 96 pages, has been issued by the Graton & Knight Manufacturing Company, Worcester, Mass. The advantages of standardization, not only in the manufacture of leather, but power transmission belting, are explained and illustrations given of the kinds of belting used for different purposes. Among other sections of interest in the bulletin are two devoted to the machine and woodworking shops. In each case, full directions are given for ordering the best belts for the individual machines. The belt widths are shown, together with the horsepower transmitted under various conditions. The last few pages of the bulletin are devoted to different methods of lapping belts, rules for obtaining tension belts, and tables containing information of value to belt users.

Packless Valves.—Every engineer, architect, fitter and user of valves realizes the importance of eliminating leaks at valve handles. The actual expense of repacking a dozen or more valves on a system may not be in itself a big item, but when the repacking of important valves necessitates tying up part of the power house equipment the incidental cost is very high. Packless valves are coming into more common use and an effective form of this valve is described in an eight-page folder published by the Defiance Packless Valve Company, Chicago, Ill. This valve has a metal to metal seat with a non-rising double taper stem upheld by a spring. It is claimed to be non-leakable. Valves of this type are fully tested before shipment and may be used for low and high pressure steam, hot and cold water, oil and air, up to and over 2,000 lb. Among the advantages claimed for the Defiance Packless Valve are simplicity of design and construction, elimination of all packing and easy turning under high pressure.

Thermit Mill and Foundry Practice.—The Metal & Thermit Corporation, New York, has just issued the third edition of the Thermit welding pamphlet No. 17, for mill and foundry repairs. The new edition has been revised and brought up to date both as regards new practices recommended and illustrations showing recent interesting repairs on certain types of equipment which were executed since the publication of the former edition.

The pamphlet begins with a general discussion of the proper applications and fields for oxy-acetylene, electric and Thermit welding, respectively. It then describes in detail the methods to be followed and apparatus used in welding iron and steel sections in general. Later it outlines thoroughly special applications of Thermit welding, such as for crankshaft, pinion and roll repairs, and also for cast-iron welding. Not previously included in former editions of this pamphlet is a description of a new method of welding teeth in pinions. The pamphlet concludes by explaining the various applications of Thermit in foundry practice, such as for increasing the temperature of iron and steel, facilitating the introduction of other metals which it is desired to alloy for special purposes, keeping metal and risers liquid for a considerable period and making small steel castings.

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CONTENTS

EDITORIALS:
A Difficult Problem 69
What Are the Real Remedies? 69
Sharp Tire Flanges 70
Next Step in Welding Development 70
Maintain Locomotive Valve Gears 70
Turret Lathe Practice 71
For a Sound Knowledge of Heat Treating 71

COMMUNICATIONS:
Pencil Repairs and Inexperienced Foremen 71
Assigning Engines 71
New Books 72

GENERAL:
Modernizing Existing Locomotive Terminals 73
Grease Lubrication 76
Locomotives and Cars Ordered and Built in 1920 77
Car and Locomotive Prices Reached Peak in 1920 80
Three Column Frame Milling Machine 83
Increasing the Capacity of Old Locomotives 84
The Care of Locomotive Boilers 87
Reducing the Fuel Consumption of Power Plants 88
Labor Board Opens Hearings on Working Conditions 92
Questions and Answers 93

CAR DEPARTMENT:
Sulphuric Acid Tank Cars of 70 Tons Capacity 94
Cause of the Present Condition of Freight Cars 97
New Plans and Specifications for Postal Cars and Fixtures 101
A Blue Print Bath 101
The Futrell Automatic Train Line Connector 102
Journal Packing Reclamation 104
The Use of Wood in Freight-Car Construction 105
Shop Safety Gate 106
Designing Brake Heads for Uniform Shoe Wear 107

SHOP PRACTICE:
Cylindrical Grinding in 1920 109
Railroad Shop Turret Lathe Practice 111
The Reason Why Some Fusion Welds Fail 114
Staybolt and Stud Driver and Remover 118
High Pressure Pump for Air Test Rack 118
Truck for Handling Jacket Iron 118
An English Locomotive Repair System 119
Closing Triple Valve Piston Ring Grooves 122
A Short Cut in Squaring Locomotive Valves 123
Paint Spraying Locomotive Front Ends 124

NEW DEVICES:
Single Pedestal Swivel Type Car Seat 125
Heavy Duty Motor Driven Face Grinder 126
Tube Safe End with Square Shoulder 127
Two-Unit Feeding Device for Shapers 128
Thirty-Inch Shoe and Wedge Planer 129
Angle Plate with Second Face and T-Slot 129
Bolster Attachments for Metal Draft Arm 130
Compact Selective Head Engine Lathe 131
New Drive for Heavy Duty Radial Drill 132
Portable Electric Drill with Automatic Switch 132
A Scale-Proof Locomotive Crane Boiler 133
Redesigned Carbon Dioxide Recorders 133
Motor Drive for Milling Machines 134
Wood Turning Lathe of Unusual Length 134
Compact Portable Air Compressor Units 135
Efficient Rotary Piston Type Pump 135
Baker Boring and Drilling Machine 136

GENERAL NEWS:
Notes 137
Meetings and Conventions 138
Personal Mention 138
Supply Trade Notes 139
Trade Publications 142

A Difficult Problem

The statement made by J. C. Fritts, master car builder of the Delaware, Lackawanna & Western in a paper before the January meeting of the Western Railway Club, that a very large part of the present bad order equipment can be confined to approximately 400,000 cars is a fact which should be kept clearly in mind in considering the present unsatisfactory car conditions. The real problem may be even more sharply defined. Probably not less than three-quarters of these 400,000 cars are 30-ton and 40-ton box cars, with weak draft sills and ends, which are in circulation all over the country when the demand for cars is great. How can the extravagant maintenance expenditures, the constant delays to traffic and the constant risk and frequent damage to which the lading in these cars is subjected be eliminated? When cars are in demand there is little opportunity to improve the condition of this equipment. At such times much of it is on foreign lines and the frequent sojourns on the repair track at best result only in repairs in kind, which are not of constructive value. When away from home the only constructive measure possible is the retirement and dismantling of these cars under Rule 120. But it is evident that owners are refusing to authorize extensive retirements under this rule, and it is probable that until confidence is restored in the stability of equipment prices most of these old cars may be expected to remain in service. How, then, are they to be made fit for service? Evidently this can only be done by the owning road and the opportunity for rehabilitation is offered the owning roads only when there is a surplus of cars such as has been created by the present business recession. It is unfortunate that the opportunity is only offered at a time when the railroads are financially unable to take full advantage of it, and for that reason the results of every hour's labor that is expended should be made to produce the utmost return by thoroughly overhauling a few cars and not attempting to turn out as many cars as possible with the least amount of work per car. Only in this way may any improvement in the condition of freight cars be expected.

What Are the Real Remedies?

A careful consideration of the present unsatisfactory condition of freight cars does not suggest the possibility of finding a remedy the application of which may be expected to effect an immediate cure. The malady long ago became chronic and the symptoms are now only a little more acute than usual. No permanent improvement can be expected until the deep-seated causes are located and removed. The present conditions are due in a very large measure to the failure of each railroad to give to all cars "equal care as to inspection and repairs, regardless of responsibility for expenses of repairs." There are two principal reasons for this failure. The first is the inability of the roads to make thorough repairs in kind to cars differing from their own standards without excessive delays, and the inability under the rules to apply betterments to other than their own cars. The second reason for this failure is the lack of any incentive for the individual road to do more than the minimum amount of work necessary to get the foreign car off its line as more than this amount of work is of no direct benefit to itself. Two possibilities suggest themselves for removing the first difficulty; either a change in the rules removing some of the limitations on foreign car repairs, or the development of a more complete program of standard and interchangeable details. The first is obviously unfair to the car owners until the latter has been developed and it is improbable that any accomplishment will be obtained in either direction, except as the result of a long period of slow and painful effort. There is only one way to overcome the second great cause for the chronic state of dilapidation of freight cars and that is to provide the now lacking incentive. In the commercial and industrial world the one incentive which produces activity is the hope or prospect of profit. Railroad corporations are no different in their nature than those in other fields, and the prospect of profit on any transaction is the only incentive likely to cause whole-hearted performance. The suggestion that prices for labor and material be set high enough to show a profit above the cost of labor and material plus the overhead, offers a means of supplying this incentive. The effect of such an incentive would probably be less manifest in the amount of repairs to foreign cars than in the greater efforts by owning roads to keep their own cars in the best possible condition, in order to avoid as much as possible the payment of the high repair bills. The most beneficial effect immediately following the adoption of such a plan would probably be the retirement or complete rehabilitation of the large number of cars now in service which long since ceased to be economical carrying units. What disadvantage to such a plan can offset its value as a potent force to raise the standard of freight car maintenance?

Sharp Tire Flanges

"An ounce of prevention is worth a pound of cure" and the old saying was never more true than when applied to the malady commonly known as sharp flanges. Locomotives credited with only 20,000 or 30,000 miles keep coming again and again to repair shops with flanges worn thin on the front driving wheels. The prevention of this excessive cutting action would save the railroads thousands of dollars annually. With the long wheel base of a modern locomotive, it is practically impossible to eliminate excessive side pressure on the front driving wheel flanges, especially when rounding sharp curves. Provision for additional side play on the front wheels and in some cases setting the tires slightly nearer together helps, but by no means solves the problem. Cutting action continues, front flanges are worn to the limit of thickness, and there is a resultant serious loss of revenue while locomotives are held out of service waiting for and receiving necessary repairs.

When flanges become sharp after only a few months service, the machinery is usually in good condition and repair work on the locomotive consists of dropping the front wheels, removing the tires, applying and turning another pair and replacing them under the locomotive. In case second-hand tires, which will turn down to the required diameter, are not available, it is necessary to apply a pair of new tires and turn them, in an extreme case, from three and one-half down to two inches thick, with a resultant waste of material. In addition, the entire shop schedule is disarranged by injecting this light repair work, especially if the wheel department is already working to capacity.

It is not overstating the case to say that the problem of sharp flanges can be greatly simplified if not solved by the application and proper maintenance of some form of automatic flange lubricator, of which several are on the market. These lubricators have demonstrated their ability to reduce flange wear and cutting action to a minimum and indirectly increase the life of rails on curves and locomotive mileage. Flange lubricators are for the most part simple and automatic in action, requiring little attention, but without this little attention they become absolutely valueless for the purpose intended. If examined at least once each trip to make sure that they are not clogged with dirt or caught in such a way as to be rendered inoperative, automatic flange lubricators will go far toward solving the problem of sharp flanges.

Next Step in Welding Development

It is natural that the early stages of the development of an art such as fusion welding should be devoted exclusively to the technique of the process itself. The process has continually been put to new uses with little thought beyond questions of manipulation, the controlling factor being the convenience with which the work may be done and the large saving to be effected in material. It is not surprising that in some cases the results of the application of the process have raised serious questions in the minds of railroad officers as to the safety of the use of the process on some classes of work already well within the field of application. Cases have occurred where the employment of fusion welding to fill out tires with flat spots, heat treated parts or pieces forged too small to finish, has apparently led to failures. The only satisfactory answer to the questions raised by such instances is one founded on knowledge and not on unsupported theory. Investigations such as that made by the Chicago, Rock Island & Pacific, described elsewhere in this issue, are of the utmost value, and strongly indicate that at present there is more need for attention to the effect of the welding operations on the metals worked on than to refinements in the technique of the operations themselves. General investigation in this phase of the subject will do much to direct intelligently the future extensions in the application of the art, and by avoiding some of the pitfalls such as have already been encountered, prevent the placing of reactionary limitations on the great possibilities for economy yet unattained.

Maintain Locomotive Valve Gears

No doubt exists as to the important part played by valve gears in locomotive operation. Ease of handling, quick response of a locomotive to its throttle and economical fuel consumption all depend upon an efficient valve gear, properly maintained. Valves must be square, with leads and cut-offs adjusted to predetermined standards, or the fuel wasted in the course of a few months or a year will amount to many tons for each locomotive. Designers of the several valve gears now on the market have bent every effort to perfect them, but this is of no avail unless they are maintained so as to make efficient locomotives. In far too many cases, the irregular exhausts of passing locomotives show at once that their valves are not square, caused by careless work in the back shops or lack of attention at roundhouses. In either case, the fault should be remedied to allow railroads to profit by the resultant increased train acceleration and decreased fuel consumption. Ordinarily it takes about eight hours to set the valves on a heavy locomotive, but it is not safe to insist on an arbitrary length of time for this operation. An unexpected difficulty may often develop and delay the work two or three hours. The only safe way is to develop dependable valve setters and allow them time enough to overcome difficulties and do the job right. Valve setting is one of the last operations in repairing a locomotive and unfortunately there is a tendency to slight the work rather than delay a locomotive in the shop. This is false economy. With the high price of coal, it is especially important that locomotive valve gears be properly set and maintained in the best possible operating condition.

Turret Lathe Practice

Somewhere between the automatic and single purpose turning machine lies the field of use for turret lathes, bounded by fairly distinct lines of demarcation and within which the turret lathe has no close competitor. For quantity production, the automatic affords great possibilities of increased output at less cost per piece, while for work involving a single turning operation the common lathe usually is best adapted. Between these two extremes, however, there is a range of work best performed on the turret lathe which thus becomes an important factor in machine shop operation. Turret lathes of American make are adapted for both bar and chucking work, the change from one to the other being made easily and quickly. By working the tools in the turret and carriage simultaneously, a large amount of time is saved and the arrangement of cutting tools and stops for work involving several operations eliminates resetting many tools, reduces measurements required and speeds up the work. Many railroad shops today should be equipped with additional turret lathes and provision made for the more effective use of those already installed. Methods of tooling are very important in any attempt to secure maximum production, and attention is called to an article in this issue, showing the tooling of turret lathes for machining several locomotive parts. The sequence of operations, methods of tooling and respective times are given and the article should be of particular value to those interested in machine shop production. Probably the greatest value of the *Railway Mechanical Engineer* to shop men lies in the opportunity it offers for comparing experiences and finding out what the other fellow is doing. It is suggested that the article referred to be carefully studied and information submitted regarding any methods of machining which, in the opinion of the reader, will turn out as good work in less time than those shown.

For a Sound Knowledge of Heat Treating

The need for the greatest care, based on accurate knowledge, in the heating of steel either for forging or hardening has been quite generally too little appreciated. The wide range of possibilities for the control of the physical properties of steel by skillful heat treatment which have only recently been opened up to industry, has brought into strong relief this general lack of accurate information on the subject. To the Chicago chapter of the American Society for Steel Treating belongs the credit for one of the first practical steps to overcome this handicap. A committee of the chapter composed of men engaged in the metal working industries of Chicago has prepared the texts for a course on forging and heat treatment of steel, with the co-operation of the Armour Institute of Technology and the Lewis Institute, and evening classes are now being organized at both of these institutions. These courses are the beginning of a movement which may rapidly accelerate the practical application of possibilities in all industries which so far have nowhere been fully realized unless perhaps in the automobile industry. Manifestly, such a course cannot take the place of practical experience. Experience in the shop alone, however, unsupplemented by laboratory research or the study of the results of such research, will never make a really skilled heat treater. In no other lines of work is so much of vital importance hidden from the operator as in those involving the heating of metal, and real advancement can only come when to practical skill is added a thorough knowledge of these hidden facts.

COMMUNICATIONS

Pencil Repairs and Inexperienced Foremen

Mechanicsville, N. Y.

To the Editor:

I have read numerous letters in the *Railway Mechanical Engineer* about the mechanics in the motive power department not being efficient in their work. I disagree with some of these letters, for there is too much work done right at the foreman's desk on the reports of the inspectors and engineers with a well-sharpened lead pencil and not by the mechanic. No power can stand up under the workmanship of a little lead pencil.

It looks at times as though the superior officers would rather have the payroll look good at the end of the month than to keep the power out of the back shop, though engines cannot make any money in the shop. What is saved in one month on the payroll is taken out of one engine in one trip.

When an engine comes out of the shop, it is all painted up and the roundhouse foreman may think it does not need the wedges or the back ends keyed up for some three or four months. He may finally get around to have the wedges set up after the boxes are pounded to pieces and the old rod bushings that were taken out in the shop would sound better in the rod than the new ones. Hundreds of dollars are spent on the engine because of the roundhouse foreman who is trying to keep the engines from coming across the turntable to be inspected and the necessary work done to keep the power in shape.

This appeals to me as very poor management, not on the part of the master mechanic, but the supervisory forces under him. Just for the want of about three hours' work to reduce a back end or a front end the engine is allowed to go out and the next day it is towed in on account of a piston rod, crosshead or back end strap broken and then it is laid to poor workmanship on the part of the mechanical forces.

No foreman can bring power back to first-class shape that is ready for the shop but the new power out of the shops and from the locomotive works can be kept up and inside of eight or nine months you can see the vast difference in the number of engines that have been going to the back shop but are now in service on the road. The railroads of today need system and efficient work foremen, not a bunch of school kids to be foremen over a body of mechanics. The foremen of today ought to be in a position to direct the men, not have them directing him how a job had ought to be done along with the handling of his forces.

A. F. Barbolt.

Assigning Engines

Chapleau, Ont., Canada.

To the Editor:

In your issue of November I read over very carefully a communication by Geo. N. Clouser on assigning engines. I do not know whether Mr. Clouser has reference to some particular railroad or railroads in general; if not the latter, then it would appear that the road he has reference to has some local conditions, coupled with a shortage of power, that would make it difficult to always have a suitable engine to handle the different sizes of trains, or it shows a deplorable lack of supervision and organization to run engines of different capacity indiscriminately on all trains regardless of size.

The third paragraph, complaining of big engines on small trains and small engines on big trains, would indicate that there was absolutely no co-operation between the yard office and the engine house. If the traffic superintendent had to explain to some superior officer who knew the game *why* the locomotives were not pulling 100 per cent trains, at least in one direction and give the reason in each individual case, there should be an improvement before long or a new man on the job.

Surely the assignment of engines should be placed where it belongs, viz., with the general superintendent and master mechanic of each district. They are in a position to know where to place the right proportion of light and heavy power. It is then up to the division officers to see that each engine has 100 per cent of its haulage capacity hooked on behind the tender and it is up to the road foreman or division master mechanic and locomotive foremen to see that they are kept in a condition to do it. If there is sufficient motive power on the division or territory in question to handle the traffic, or even if they are short of power occasionally, it is the duty of the chief despatcher to know just what is doing, and get suitable engines back to the terminals where they are required in time to be put in shape to do it.

On the road where I have the pleasure of working, the operating officials are very much concerned not that they have an engine big enough to haul the train, but that they have a big enough train for the engine to handle, and this is true in the month of July as well as the month of January with its 50 below zero.

In the last paragraph of his letter Mr. Clouser advises increasing the efficiency by giving some officer the job of knowing the whole road, weight of train, profile, condition of track, characteristics and condition of each engine on the road, train schedules and all the other things that affect the problem, and from these things, plan the distribution of the motive power, while he is keeping his eye on the order in which the engines come in and out of the shop, and in a general way see that the right engine is always available. This is quite a large sized order for this particular official, especially if he has a large territory to look after.

I don't think Mr. Clouser has solved the power problem of this particular road yet if he expects to get efficiency out of a "particular officer" who has assigned to him the multitude of duties that Mr. Clouser would hang on to him. Railroads are not run in a general way any more; in this country they are run by an organization, each one of which knows his particular part of the business and he has to put up the goods; then there is a blue print sent to him to let him know how he is getting along, and if the figures on this print do not compare favorably with performances in the past, then there is a note asking him "why" and his job depends on his explanation.

JOHN H. BROOKES,
Division Master Mechanic, Canadian Pacific.

NEW BOOKS

The Engineering Index for 1919. *Published by the American Society of Mechanical Engineers,* 29 *West 39th Street, New York.* 527 *pages,* 9 *in. by* 6 *in. bound in cloth.*

The purpose of the Engineering Index is to provide a convenient and satisfactory guide to engineering literature. The 1919 edition of this index is the most complete and comprehensive work of its kind ever published. It contains over 12,000 references to articles published during the year 1919 in nearly 700 engineering and allied technical publications. The compilation of this index is based upon a review of approximately 1,100 periodicals, reports, and other publications by the engineering staff of the American Society of Mechanical Engineers. These publications are printed in ten different languages and comprise what is probably the most complete collection of scientific and engineering publications in the world. All of the publications referred to in this index are now a part of the Engineering Societies' Library of New York.

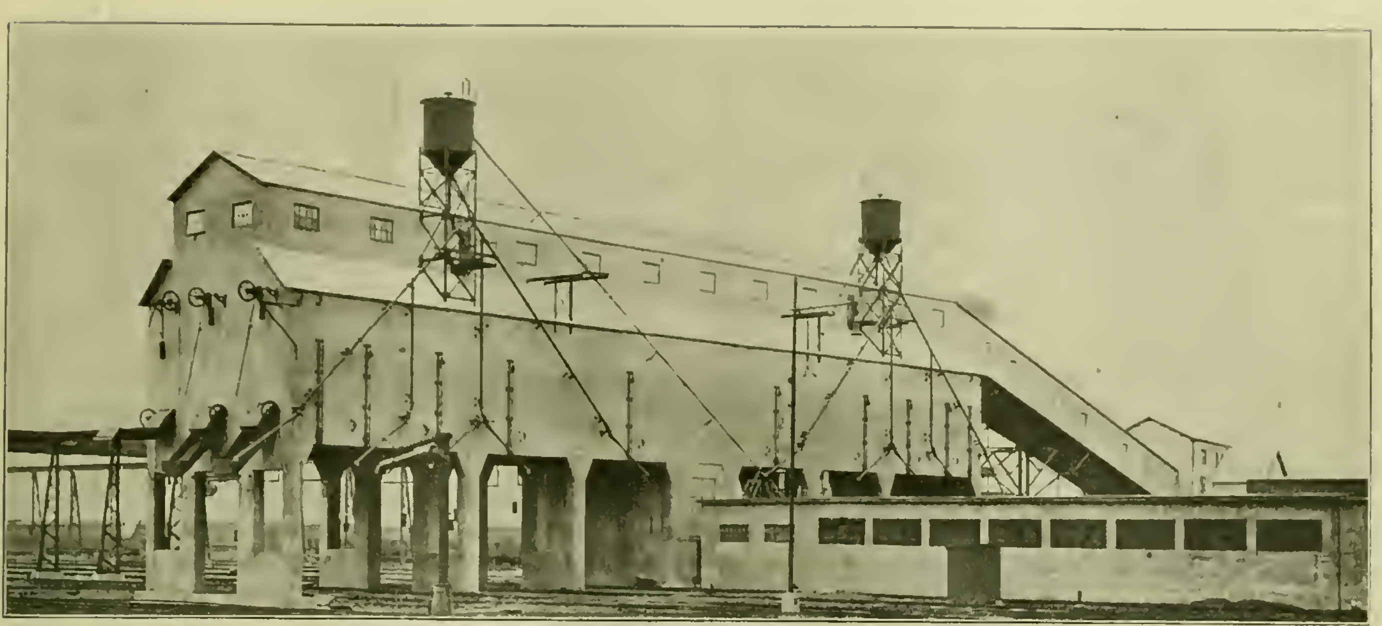
Practical Locomotive Running and Management. By W. G. Knight, 519 *pages,* 5 *in. by* 7 *in., illustrated, bound in cloth. Published by the author, W. George Knight,* 35 *Cushing street, Medford, Mass.*

This is the second edition of a very popular book on locomotive operation that is distinguished by its plain common sense treatment of the many difficult problems encountered by those responsible for the operation of locomotives. The first chapters of this book are devoted to the fundamental facts relating to combustion and the generation of steam. In this connection the function of the brick arch of the superheater and other smaller appliances essential to the efficiency and capacity of the locomotive are described. The maintenance as well as the operation of these devices is dealt with in a commendable manner. There is also a chapter on locomotive front end appliances with particular references to the effect of these appliances upon the operation of the locomotive. Locomotive valve gears and the air brakes are discussed in separate chapters. The chapter on locomotive running is one that could be read to advantage by any locomotive engineer or supervisor of locomotive operation. The final chapter, which deals with a general study of the modern locomotive, does not, of course, deal with this subject in its entirety but contains a good deal of information in a convenient form relating to the principles involved in the design and operation of these modern locomotives. It should be understood, however, that this book does not add any amount of original matter to the subject and would not appeal to anyone who has already made a thorough study of the entire field. The great value of the book will be found in its use as a reference and guide by enginemen, fuel and locomotive supervisors.

Fuel Oil in Industry. By Stephen O. Andros. 240 *pages,* 9 *x* 6 *in. Illustrated. Bound in cloth. Published by the Shaw Publishing Company,* 910 *South Michigan Boulevard, Chicago.*

The use of fuel oils by the railroads is by no means new and the problems involved in its application to the locomotive have been carefully studied by railway engineers for many years; in fact, the value of this book to the railway mechanical or civil engineers might be questioned if it were not for the tremendous expansion in the use of fuel oil in all industries within recent years. Thus the increased price of bituminous coal has assisted in promoting the use of fuel oil both in maritime service and in many hundreds of stationary plants along the eastern seaboard. This has introduced new problems relating to its transportation in bulk and storage in large quantities. Moreover, it must be admitted that refinements bearing upon the handling and burning of fuel oil are generally given more consideration in stationary and maritime service than in railroad use. For this reason, there is a field for a book of this character in railroad as well as industrial service which outlines as it does not only the principles of fuel oil combustion and the properties of fuel oil but the method of testing, storing and burning it, together with a full description of its application to industrial and domestic furnaces.

For instance, the book not only describes many of the details involved in the construction of steel storage tanks but refers to an interesting development in concrete oil storage tanks and describes at length all of the pipe setting and auxiliary machinery involved. While the book describes many types of burners that would not be applicable to locomotive service, still there are many points in connection with this subject as outlined in this book that will prove of particular interest to railway fuel engineers. The use of fuel oil in the manufacture of iron and steel and the heat treating furnaces is also described and illustrated in an interesting way.



1,600 Ton Reinforced Concrete Coaling Station, C. of N. J., Communipaw, N. J., Serving Ten Tracks with Three Kinds of Coal

Modernizing Existing Locomotive Terminals*

Important Details of Locomotive Terminal Design Outlined at Railway Section Meeting of A.S.M.E.

BY G. W. RINK

Asst. Supt. Motive Power, Central Railroad of New Jersey

LOCOMOTIVE terminals play an important part in the operation of the railroad, as the transportation department is at all times entirely dependent upon them for its supply of serviceable power for the movement of both passenger and freight cars. Should the capacity of the terminal or the facilities for making repairs be inadequate, the result will soon reflect itself in more time being required to prepare engines for service and more frequent detention on the road due to failures.

The general layout of engine terminals, also the extent of shop facilities provided, depends entirely on their location with reference to the general locomotive repair shop. When located in close proximity it is necessary to provide only such facilities as may be necessary to make the general run of roundhouse repairs, depending upon the main shop for the manufacture and supply of a large percentage of materials required for use at the terminal. But when engine terminals are located some distance from the general locomotive repair shops, they should be provided with enlarged facilities so as to perform all the necessary machine, blacksmith, and boiler-shop operations required when making more extensive repairs, and be entirely independent of the main shop. It is important, however, to eliminate at the terminals the manufacture of such standard parts as may be produced elsewhere at less cost. At outlying points where only light repairs are made to maintain locomotives in serviceable condition, such facilities as described above are not necessary.

At all important terminals the measure of efficient operation is the time required to prepare locomotives for service and the mileage which can be obtained between shoppings for class repairs. Any saving in time of course permits more intensive use of locomotives when transportation requirements make it necessary, but this saving can only be accomplished by providing a first-class terminal layout with proper equipment so as to enable the terminal organization to handle all engines with promptness and despatch. This requires a properly balanced organization to perform the various classes of work required and, coupled with modern labor- and time-saving facilities, should tend to reduce congestion materially and maintain the equipment properly.

Repairs at Locomotive Terminals

The location of the engine terminal with reference to the general locomotive repair shop will have some bearing on the necessity of performing relatively heavy repairs at the terminal. Where they are within reasonable distance of each other, it may be desirable to have a considerable part of the heavy repair work transferred to the main shop, where the repairs can be performed more expeditiously and the engine returned to service. On the other hand, this class of work has a tendency to interfere with the output of the locomotive repair shop, and especially so if it is found difficult to maintain the necessary quota of class repairs, considering the equipment as a whole. In such cases it would appear more desirable to increase the engine-terminal forces and provide sufficient facilities to at least make Class 5 repairs and the general run of heavy running repairs, including the removal and reapplication of a part or complete set of flues.

Where it is found desirable to perform such heavy repair work, it should preferably be done in a small building located adjacent to the machine shop, and provided with several tracks for holding engines and an overhead crane or power-driven locomotive screw hoist for the removal of all wheels. This feature is very desirable, especially if heavy locomotives are to be handled. It also increases the track capacity within the roundhouse to that extent and repairs can be made more promptly and economically.

With reference to existing terminals, a careful study of the

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*From a paper presented at the annual meeting of the American Society of Mechanical Engineers, December 8, 1920.

property will no doubt disclose the fact that improvements can be made whereby greater efficiency may be obtained. Modern facilities should be installed wherever it is possible to produce a saving in time and labor.

Coal, Sand and Ash Handling Facilities

The type of coaling stations selected must depend on the number of engines handled, the number of tracks which may be available for coaling engines and the kind of coal to be handled. Some roads in the East use bituminous, broken anthracite, and buckwheat. Where the quantity of coal handled is small, the locomotives can be coaled from an elevated platform using one-ton buckets or by means of a locomotive crane direct from car. When it is necessary to deliver coal to two or more tracks, a mechanical type of coal-handling apparatus is generally installed. Marked improvements have been made in receiving, hoisting and distributing equipment, which has resulted in smaller operating forces being required. Measuring devices are also installed for recording the amount of coal delivered to tenders. An electric winch should be provided at large terminals at the loaded coal-car track so that cars can be hauled to position over track hopper.

The sandhouse should be located at the coaling station. Sufficient wet-sand storage space should be provided as well as means for drying the sand by coal stove or steam. Compressed air should also be available so that the sand can be delivered to overhead storage bins, having suitable outlets to deliver the sand direct to engine by gravity. All important engine terminals should have a complete installation of this character.

During recent years the tendency when constructing large terminals has been to install pits filled with water. The cinders drop directly into the water and move toward the center of the pit, due to the outer wall sloping inwardly, and are removed either by a locomotive crane or by an overhead crane traversing the entire length of the cinder pit, the cinders being deposited by means of grab buckets directly into cars located on the loading track. The pit is filled with water to a depth of about five feet, water being admitted at one end of the pit and overflow provided at the opposite end. Provision is made to protect the floor of the pit against injury by the grab bucket, by imbedding old rails in the concrete. Due to the quantity of water required for large installations of this character, provision should be made if possible for a supply from a nearby stream or other natural source.

Steam-jet ash conveyors can be installed to advantage where ample supply of steam is available. The system consists of an 8-in. cast-iron pipe made exceedingly hard to withstand wear, with intakes provided at suitable intervals. The cinders are drawn by suction through the main pipe line and then propelled by means of the steam jet direct to car or storage bin, suitably located. Cinders handled in this manner are not wetted down until they enter storage bin, where a water spray is provided. This type of cinder conveyor has proved very satisfactory for handling cinders in power houses and should give good service when installed in connection with small engine terminals.

Inspection Pits

Inspection pits are now being installed at a number of large engine terminals. These are located on the inbound tracks with the view of making inspection of locomotives before they are placed over the cinder pit. Fires can then be withdrawn when the engines pass over the cinder pit, if inspection develops defects which warrant this procedure, thus saving time and expense involved if engine was inspected within the roundhouse after passing over cinder pit. There are many advantages in having inspection made at this time as the foreman by means of pneumatic tubes can be furnished with both the engineer's and inspector's reports showing work to be done before engines are placed in the shop.

These inspection pits are generally made about 100 ft. long, two in number, and covered with a protection shed. Special arrangements are provided to permit inspectors to enter the pits. Proper drainage and lighting facilities are also provided. In lieu of reporting on inspectors' reports such work as loose nuts, missing cotters, etc., it would be desirable to station at these inspection sheds mechanics who can perform this work at once, thus saving time in locating these defects in the shop after being reported.

Heating and Ventilation

Heating and ventilation is of first importance in a modern and efficient roundhouse. With the possible exception of small isolated houses in mild climates a properly designed system combining heating and ventilation should be adopted. An installation of this kind consists of a blower drawing air through hot-blast heaters located in a fan room which forms a projection on the outer wall of the roundhouse. The heated air is discharged through an underground concrete duct system.

A combined heating and ventilating system should supply sufficient air for the quick removal of smoke, gas and vapors. Ventilating sash, louvers and other openings should be provided at the high points of the room to supplement the forced system by directing the flow of air currents and facilitating the removal of hot gases. This feature should be carefully considered, for in roundhouse ventilation it is not so much a question of diluting the air as it is of establishing a positive flow of air which will carry the gases along with it.

It is sometimes necessary, due to the requirements of local ordinances or because the type of house prevents the use of smoke jacks above the locomotive stacks, to install an exhaust system so as to remove gases directly from the locomotive smokestacks. In the latter case connections are made to the smokestacks by means of swinging hoods. This system is not necessary from a ventilating standpoint, and should only be installed where conditions compel its use.

With the usual type of indirect system the fan rooms, one or two in number depending on the size of the house, should be located midway of the length of the house to be served, thereby reducing the temperature drop of the air in the duct as well as the friction head against which the fan must work. The quantity of air supplied together with the number, size and location of air outlets depends largely on the type, size, and location of the roundhouse. The amount of heat to be supplied with the air is also a variable factor and should have careful study so as to provide a comfortable working temperature under the conditions obtaining in roundhouse operation.

The question as to whether the fan should be motor- or engine-driven depends on the quantity of exhaust steam available for heating and whether or not it is desired to operate the fan for ventilation in the summer time. The hot-blast heaters should be operated through a two-pipe vacuum system, particularly where exhaust steam is available, so as to reduce the back pressure and provide a positive circulation of steam through all parts of the heaters. The temperature of the air can be regulated to suit the variable outside temperature by subdividing the heater into units with a control valve on each. The fan should be operated at a constant speed so as to make the ventilation independent of the heating and to provide a uniform condition at all times.

Lighting

Adequate daylight facilities through large window areas together with light, cheerful surroundings are highly desirable. The windows should be spaced and located so that daylight conditions are fairly uniform. They should also provide sufficient daylight so that artificial light will be required only during those portions of the day when it would naturally be considered necessary. Good natural and artificial light will reduce accidents, provide greater accuracy in workmanship and simplify the supervision of the men.

Much needed improvement is desired in connection with artificial lighting of engine terminals. In the roundhouse proper, lights mounted on the outer wall and reflected between engine pits have given satisfactory results when augmented by sufficient lights suspended from the ceiling to afford general illumination. Machine shops, etc., should be provided with a general or overhead lighting and also supplemented by individual lamps conveniently placed, preferably on brackets so that they may be adjusted.

For lighting the roundhouse circle, flood lights should be used whenever possible as general illumination will add considerably to the safe movement of locomotives to and from turntable and engine house. Ash pits can be illuminated by rows of reflector lights placed on poles, and similar provisions should be made at other points beyond turntable or by the use of flood lights on the tops of coaling stations. The introduction of many new types of lamps has made it possible to provide better illumination when changing from an old to a new lighting system. A study should be made of the conditions and proper lamps selected for the purpose.


Modern Ash Pit of the Central of New Jersey

Hot-Water Washout and Refilling System

Facilities should be provided for washing out boilers, using hot water under pressure and refilling with hot water after washing. There is an actual saving in time as compared to the old system of washing out and refilling with cold water; with this system boilers are washed out more thoroughly and strains within the boiler due to expansion and contraction are considerably reduced, with the result that the cost of boiler maintenance is reduced.

There are two types of installations for this purpose in general use, one of which utilizes the blow-off water for washout purposes only, while the other utilizes as much of the blow-off water as necessary for this purpose and the remainder, after being clarified, for refilling purposes. As blow-off water is always soft and becomes clarified soon after storage, it is of course the best water for the generation of steam and its reuse in this manner is responsible for the greater efficiency of the latter type of installations.

Hot-water washout and refilling systems can be economically installed in any size to meet the equirements in any engine terminal of moderate size. The usual practice is to deliver washout water at temperatures varying from 100 deg. to 140 deg. The refilling water generally has an average temperature of approximately 210 deg. Where such systems have been introduced, there is a material reduction in time required to do this work. Boilers have been blown off, refilled, fired, and steam pressure brought up to 100 lb. within from two to three hours. This does not include such time as may be required to make necessary repairs to boilers.

Wheel-Dropping Facilities

The usual wheel-dropping facilities consist of a drop-pit system which provides for depressed pits at right angles to shop track, using telescoping pneumatic or hydraulic jacks for lowering and raising wheels, separate pits and jacks being installed for handling driver and engine-truck wheels.

Screw-jack locomotive hoists especially designed for unwheeling locomotives are being more extensively used at engine terminals, and their use has made possible a larger saving in both time and labor. These hoists operate with a high degree of safety as compared with the drop-pit system; furthermore they can be located within the roundhouse or installed in a separate building, in which case it would be desirable to also install the wheel lathe and other tools and appliances for taking care of heavy running repairs.

When screw-jack locomotive hoists are installed, it does not eliminate the necessity for providing drop pits in the roundhouse, which may be needed in order to prevent loss of time in making repairs to locomotives which may only require the dropping of a single pair of drivers or engine-truck wheels.

Machine, Boiler and Smith Shops

Old and obsolete tools should be replaced by modern machine tools, which insure increased production at lower costs and the work being done more accurately and promptly and power maintained in better condition. Individual motor drive for the larger machines and group drive for the smaller machines are preferable. Facilities should include steam hammer, forges with down-draft hoods (number and size to suit work to be performed), punch and shear, plate-bending rolls, straightening plate, flange fire, etc.

Autogenous cutting and welding outfits are also considered indispensable and are used principally in making repairs to locomotive fireboxes, engine frames and in reclaiming miscellaneous parts which can readily be repaired by means of this process.

The Power House

Important engine terminals should be provided with a power plant of sufficient size to take care of the future as well as immediate needs of the terminal. In a number of cases this plant is required to provide steam for thawing snow at switches on main-line track leading to the terminal passenger station and supply heat and light to station buildings, and function in general as a service station. Labor-saving devices should be installed in the way of coal- and ash-handling machinery, automatic stokers and large-capacity overhead coal-storage bunkers. Consideration should be given to operating with condensers, requiring a cooling tower if fresh water is used, the surplus water being delivered to flood ash pit for locomotive cinders if this type is used. Tanks of ample capacity should be located at power house with water mains of proper size supplying water for shop use and filling of tenders at terminal tracks, locating water columns away from switches in cold climates to prevent freezing. At smaller terminals, discarded locomotive boilers are used to furnish steam for power and heat. A close study made of these installations will reveal the fact that in many cases money can be saved by the use of modern water-tube boilers.

Discussion

The discussion of this paper was featured by the remarks of a representative of the operating department of the Pennsylvania Railroad, Mr. Wm. Elmer, division superintendent at Altoona. Mr. Elmer discussed the most important phases of the locomotive terminal situation with particular reference to its effect upon locomotive performance on one of the busiest railroad divisions of the United States. Confronted with the problem of getting the utmost service out of every available locomotive, Mr. Elmer has developed a unique system of records indicating the service performed by each locomotive on his division which he described at some length in the course of his discussion.

The paper on Modernizing Locomotive Terminals was also discussed by representatives of the Robinson and Austin Construction Companies who have recently been engaged in very extensive terminal development. Appropriate emphasis was laid on some of the most vital features in terminal construction and an attempt was made to demonstrate that the value of terminal improvements can be arrived at by capitalizing the enhanced earning power derived from locomotives handled in modern vs. obsolete terminals.

The discussion was closed by L. G. Plant, associate editor of the *Railway Mechanical Engineer,* who stated that consideration of the locomotive terminal from any angle would be incomplete if it did not place sufficient weight on the outstanding function of the terminal, which is to expedite the movement of locomotives, and emphasized those features of terminal development which have the most direct bearing upon the time element involved in handling locomotives.

Grease Lubrication

BY T. J. HOLMES
Swain Company, Chicago

Friction prevents machinery from being efficient. One writer gives it as his opinion that 50 per cent of the power used in the United States is wasted on unnecessary friction.

The economical running of all kinds of machinery depends largely upon the character and application of the lubricant. From the smallest to the largest and most complicated machine, the question of lubrication is of foremost importance. The cost of a lubricant is often very small in comparison with the amount of loss that may be sustained through friction, if an inefficient lubricant is used.

The parts of a bearing cannot be turned absolutely true and smooth. Rough places not visible to the naked eye are likely to exist. If these are ground together without lubrication, friction and heat result. The lubricant is employed to fill in the bearing, and to prevent friction. As a means of filling up any rough places in a bearing, a lubricant which carries a small amount of flake graphite or mica may be used to good advantage.

The following discussion applies only to those bearings where a stiff grease lubricant should be used. The term "grease" strictly applies only to animal fats, especially when in a soft state. In recent years, however, the term has been enlarged to include other products, but it properly includes only those possessing unctuousness or a soapy, slippery feeling in a marked degree.

What particular thing is there in grease that gives it lubricating qualities? This question has long puzzled persons interested in lubrication. Experience and investigation have led to the conclusion that the lubricating quality of grease is largely produced by fatty particles or colloids, constantly in motion, which are characteristic of the structure of grease. Greases which have not been subjected to high temperature possess great lubricating qualities, while those greases which have been subjected to a high temperature, either in refining or in use on hot journals, do not have the best lubricating qualities. Heat is destructive of the moving colloids, and therefore destructive of the lubricating qualities of a grease.

Any material used as a lubricant should have the following qualities:

(1) Adhesion, the property which causes it to cling to the surface to be lubricated. It is well known that certain fats cannot be entirely rubbed off a smooth surface and that water will not remove them. Soap and water must be used in order to remove them effectually.

(2) Cohesion, the property causing the particles of a lubricant to hold together.

(3) Unctuousness, that property which gives a greasy, slippery feeling to the touch.

The lubricating colloids seem to have much to do with all three of these necessary qualities and without their presence any material is of little or no value as a lubricant.

Tests for melting point and flash, as applied to lubricants, would therefore seem to be of little use in determining lubricating qualities. To judge lubricating qualities, tests should more properly be aimed at the determination of the relative amount of lubricating colloids in the make up of the material.

It is generally conceded that a good lubricant should be neither strongly acid nor strongly alkali, but should be neutralized so that no injury may result to the bearings or to the essential qualities of the lubricant.

Action of the Lubricant

When the bearing is perfectly adjusted and the journal started in motion, the lubricant is gradually drawn down around the journal, filling the entire space between the journal and box, and adhering to both wearing surfaces. The colloidal globules permit the journal to roll and slide over them, and at the same time they slip or roll past each other. This motion of the particles of the lubricant takes place without friction and consequently without the generation of heat.

If a journal is removed after running in a grease lubricant, a magnifying glass will disclose a thin film or coating. This film may be destroyed by heat, by foreign substances, or mechanical defects in the machinery. Furthermore, if the lubricant contains few colloids, the running of the journal may be accompanied by high friction and the generation of a large amount of heat.

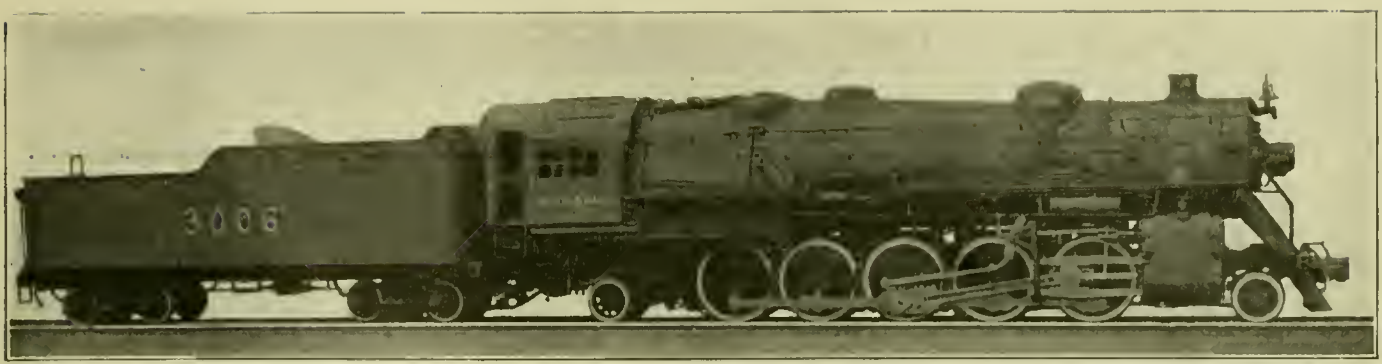
Every lubricant has its own lubricating temperature; that is, a point at which it yields the greatest degree of efficiency. The lubricating point should be low as no bearing should be permitted to "get hot." The efficiency point in a lubricant should not be confounded with the melting point. These two temperatures are often far separated and have little relation to each other. This relation varies with the materials used as lubricants.

As a rule, the degree of running temperature indicates the quality of the lubricant, but it may also be affected by the character of the work, or by mechanical defects in the bearing. Graphite or mica, although not lubricants themselves, may be used in moderate quantities to advantage in grease lubricants as they tend to fill up and smooth over rough or pitted bearing surfaces.

When machinery stands idle for a time, the weight of the journal is apt to force the lubricant out of the bearing, and it takes a little time for the re-establishment of a complete lubricating film. When a proper lubricant is used, the rotation of the journal will permit enough of the lubricant to work out at the ends of the box, to form rings which exclude moisture and dirt from the journal when it is not in motion.

It is necessary, not only to have good bearings and lubricants, but to have the lubricant applied by the proper method. The lubricator cup should fit tight and exclude all dust and grit. Indicators should be used on all bearings. Concealed lubricators often give rise to costly trouble because inspection cannot be readily made.

A poor system of lubrication, once installed, is difficult to change. It is advisable, therefore, when planning a new shop, that lubrication receive careful attention.



One of Twenty Santa Fe Type Locomotives Built by the American Locomotive Company for the Boston & Maine

Locomotives and Cars Ordered and Built in 1920

Considerable Increases Over 1919 Figures But Little Progress in Making Up Accumulated Shortage

THE locomotives ordered by the Class 1 railroads in 1920, according to the statistics of the Railway Age, reached a total of 1,668—almost eight times the number ordered for all domestic service in 1919. The orders placed by other railroads in the United States amounted to 103 and by industrial concerns to 227, making a total of 1,998 for all domestic purchases—more than nine times the similar total for 1919.

The orders by Canadian roads and industries from builders either in Canada or the United States were 189 and the orders received by American builders from foreign countries amounted to 718, making a grand total for all orders of 2,905. In 1919 the total Canadian orders were 58 and the foreign orders 898. Thus it will be seen that there was a considerable increase in orders from every source except in the export trade. Here the 1920 total is 180 less than the 1919 figure.

Table I—Locomotive Orders of 1920

For Class I Railroads	1,668
For Other American Railroads	103
For Domestic Industrials	227
Total Domestic	1,998
For Service in Canada	189
For Export to other Countries	718
Grand Total	2,905

The year 1919 set the low mark for locomotive orders as far back as records have been kept. In view of this fact, the 1920 orders cannot be considered excessive, as may easily be seen by reference to Table II. The totals for 1916, 1917 and 1918 all exceed the figures for 1920. The totals for 1917 are as large again as the figures shown in the present compilation. During these years greatly increasing demands on the railways together with a steady upward movement of prices which looked as if it would continue indefinitely brought about an economic condition which generally increases buying in almost every field. Then, too, during the war period it was felt that something approaching an adequate number of locomotives had to be provided regardless of cost, and under the regime of the Railroad Administration government credit was available for such purposes.

The orders this year were financed by the railroads themselves, with some help from the government to be sure, during the period of readjustment attendant upon the return of the carriers to their owners, when railway costs were nearing their peak and before adequate returns had been provided by a new rate structure. In view of these facts the showing for 1920 is not entirely unsatisfactory, although it is quite evident that nothing has been done during the past year to make up for deficiencies in the annual purchases of locomotives which have been accumulating since 1912.

The foreign orders for 1919 made up more than 75 per cent of all orders placed. In 1920 conditions were quite different, because foreign orders have been small. This decrease in orders from abroad is disappointing; it can be traced to the premium on the dollar which has increased generally throughout the year in most countries and which makes it possible in some cases for foreign manufacturers to underbid our own; to the fact that foreign competitors have been able to increase their production and to direct their efforts once more to their old markets; and to the generally impoverished condition of the countries which most need to replenish the inadequate stock of locomotives on their railways. One of the most noteworthy orders from foreign countries which was placed in the United States during the year was from Roumania for 50 locomotives. This order was divided equally between the Baldwin Locomotive Works and the American Locomotive Company and payment for it was made in petroleum.

Table II—Orders for Locomotives Since 1901

Domestic Orders Only

Year	Locomotives	Year	Locomotives
1901	4,340	1908	1,182
1902	4,665	1909	3,350
1903	3,283	1910	3,787
1904	2.538	1911	2,850
1905	6,265	1912	4.515
1906	5,642	1913	3,467
1907	3,482	1914	1,265

Domestic and Foreign

Year	Domestic	Foreign	Total
1915	1,612	850	2,462
1916	2,910	2,983	5,893
1917	2,704	3,438	6,142
1918	2,802	2,086	4,888
1919	272	898	1,170

The number of locomotives built in the United States for domestic service during 1920 was 1,857 and for export 1,582, making a total of 3,439. In Canada the production was 165 for domestic use and 68 for export, making a total of 233 and a grand total of all production in the United States and Canada of 3,672. This figure represents an increase of 400 over the similar total, 3,272, for 1919. The total built in the United States for domestic service in 1920 is some 200 less than the domestic production in 1919, but the figures for the Canadian and export production combine to show a definite increase in the grand total.

Due to the failure of two large locomotive builders to furnish figures showing the number built for export, it has been necessary to estimate the production of these builders from other sources, which, however, are believed to be sufficiently accurate for purposes of comparison.

Table III. The Locomotives Built

	United States	Canada	Total
Domestic	1,857	165	2,022
Foreign	1,582	68	1,650
Total	3,439	233	3,672

Comparison with Previous Years

Year	Domestic	Foreign	Total	Year	Domestic	Foreign	Total
1896	866	309	1,176	1908*	1,886	456	2,342
1897	865	386	1,251	1909*	2,596	291	2,887
1898	1,321	554	1,875	1910*	4,441	314	4,755
1899	1,951	514	2,475	1911*	3,143	387	3,530
1900	2,648	505	3,153	1912†	4,403	512	4,915
1901	...	...	3,384	1913†	4.561	771	5,332
1902	...	...	4,070	1914†	1,962	273	2,235
1903	...	...	5,152	1915†	1,250	835	2,085
1904	...	...	3,441	1916†	2,708	1,367	4,075
1905*	4,896	595	5,491	1917†	2,585	2,861	5,446
1906*	6,232	720	6,952	1918†	3,668	2,807	6,475
1907*	6,564	798	7,362	1919†	2,162	1,110	3,272

*Includes Canadian output.
†Includes Canadian output and equipment built in railroad shops.

If the locomotive orders for the preceding year give any data by which production for the following year may be estimated, we can safely assume that the output of locomotives in 1921 should exceed measurably the production for 1920. The fact confronts us always that American roads have for several years fallen far behind in acquiring new motive power and that sooner or later the lack must be made good.

Table IV. The Passenger Car Orders of 1920

For Class I Railroads	1,115
Other Domestic (including Pullman Co.)	666
Total Domestic	1,781
For Service in Canada	275
For Export to other Countries	38
Grand Total	2,094

More Passenger Cars Ordered and Built

The totals for orders of passenger cars during the past year show an upward trend. A total of 1,115 cars was ordered by Class I roads during the year and 666 by other railroads and private car companies in the United States, including the Pullman Company. These figures added together give 1,781 as a total for the year's domestic orders, a figure which compares quite favorably with the orders in 1917 and 1918—as well as 1919.

Table V. Orders for Passenger Cars Since 1901

Domestic Orders Only

Year	Passenger cars	Year	Passenger cars
1901	2,879	1909	4,514
1902	3,459	1910	3,881
1903	2,310	1911	2,623
1904	2,213	1912	3.642
1905	3,289	1913	3,179
1906	3,402	1914	2,002
1907	1,791	1915	3,101
1908	1,319		

Domestic and Foreign

Year	Domestic	Foreign	Total
1916	2,544	109	2.653
1917	1,124	43	1,167
1918	131	26	157
1919	639	143	782

Canadian orders for the year were 275—72 less than the 1919 figure. Export orders have dropped even more sharply. Export orders for 1920 were only 38, which is a rather poor showing in comparison with the total of 143 in 1919. Passenger car building has, however, been at a minimum the world over for some years, although eventually it must increase greatly. The grand total of passenger car orders for domestic service and export in this country and in Canada was 2,094—1,312 more than the 1919 figure, an increase brought about entirely by greater orders from the roads and other buyers in the United States.

The production of passenger cars during 1920 in the United States for domestic use was 1,272 (including cars for Pullman Company service) and for export 168. These figures show decided improvement over the similar figures, 306 and 85 respectively, for 1919. The cars built are described as: all steel, 1,240; steel underframe only, 171; wood, 21, and not specified, 8.

Table VI. Passenger Cars Built

	United States	Canada*	Total
Domestic	1,272	....	....
Foreign	168	....	....
	1,440	....	....

*Complete details Canadian production not received.

Comparison with Previous Years

Year	Passenger Domestic	Passenger Foreign	Passenger Total
1899	1,201	104	1.305
1900	1,515	121	1,636
1901	1,949	106	2,055
1902	From 1902 to 1907 passenger		1,948
1903	car figures in these two		2,007
1904	columns included in corre-		2,144
1905*	sponding freight car columns.		2,551
1906*	.....	...	3,167
1907*	.....	...	5,457
1908*	1,645	71	1,716
1909*	2,698	151	2,849
1910*	4,136	276	4,412
1911*	3,938	308	4,246
1912†	2,822	238	3,060

*Includes Canadian output.
†Includes Canadian output and equipment built in company shops.

	United States			Canadian			Grand
Year	Domestic	Foreign	Total	Domestic	Foreign	Total	Total
1913	2,559	220	2,779	517	....	517	3,296
1914	3,310	56	3,366	325	....	325	3,691
1915	1,852	14	1,866	83	....	83	1,949
1916	1,732	70	1,802	37	....	37	1,839
1917	1,924	31	1,955	45	....	45	2,000
1918	1,480	92	1,572	1	....	1	1,503
1919	306	85	391	160	....	160	551

Most of the larger orders for passenger equipment were placed relatively early in 1920. The car building companies started the year with orders for domestic service on hand and undelivered amounting to 407. The traffic congestion, the difficulty of securing raw material and related conditions prevented them from getting production under way with any great degree of speed. The orders on hand at the end of November had reached a total of 925.

Freight Car Orders Increase; Production Still Low

In the number of freight cars ordered during 1920 there has been, as was the case with the locomotives, a remarkable improvement over the 1919 showing. The orders by Class I roads were 51,250 cars, by other domestic roads 1,044 and by private car lines and industrials 31,913—making a total of 84,207 cars ordered in the United States for domestic service. To this figure are added the total orders of 12,406 placed by Canadian roads and industries and 9,056 ordered by foreign buyers, which brings the total orders received in this country and Canada during the year up to 105,669.

Table VII. The Freight Car Orders of 1920

For Class I railroads	51,250
For other American railroads	1,044
For private car lines and industrials	31,913
Total domestic	84,207
For service in Canada	12,406
For export to other countries	9,056
Grand total	105.669

In 1919 the total domestic orders were 22,062—scarcely one-fourth the 1920 total. Canadian orders of 3,837 for 1919 are scarcely a third of the purchases for 1920 and the export orders of 3,994 are less than one-half the total purchases for export during 1920.

As was pointed out in the review of the locomotive orders for this year, the showing for freight car orders is not entirely unsatisfactory in view of the uncertain conditions which prevailed throughout the greater part of the period, even the close of which brought no conclusive proof that the rate structure provided by the Interstate Commerce Commission was going to provide adequate returns to the carriers. The fact remains, however, that the acquisitions of freight cars in 1920 were far from sufficient to make up the deficiencies in orders which have accumulated during the past eight years. The showing of freight car orders for 1920 does not even compare favorably with the totals for any recent year with the exception of 1914 and 1917. The domestic orders in 1918 alone were for some 40,000 more than in 1920.

Table VIII. Orders for Freight Cars Since 1901

Domestic Orders

Year	Freight cars	Year	Freight cars
1901	193,439	1908	62,669
1902	195,248	1909	189,360
1903	108,936	1910	141,024
1904	136,561	1911	133,117
1905	341,315	1912	234,758
1906	310,315	1913	146,732
1907	151,711	1914	80,264

Domestic and Foreign

Year	Domestic	Foreign	Total
1915	109,792	18,222	128,014
1916	170,054	35,314	205,368
1917	79,367	53,191	132,558
1918	123,770	53,547	177,317
1919	25,899	3,994	29,893

Table IX. Freight Cars Built

	United States	Canada*	Total
Domestic	60,955	......	......
Foreign	14,480	......	......
	75,435	......	......

*Complete details of Canadian production not received.

Comparison with Previous Years

Year	Freight		
	Domestic	Foreign	Total
1899	117,982	1,904	119,886
1900	113,070	2,561	115,631
1901	132,591	4,359	136,950
1902	161,747	2,800	162,599
1903	153,195	1,613	152,801
1904	60,955	1,995	60,806
1905*	162,701	5,305	165,155
1906*	236,451	7,219	240,503
1907*	280,216	9,429	284,188
1908*	75,344	1,211	76,555
1909*	91,077	2,493	93,570
1910*	176,374	4,571	180,945
1911*	68,961	3,200	72,161
1912†	148,357	4,072	152,429

*Includes Canadian output.
†Includes Canadian output and equipment built in company shops.

Year	United States			Canadian			Grand Total
	Domestic	Foreign	Total	Domestic	Foreign	Total	
1913	176,049	9,618	185,667	22,017	....	22,017	207,684
1914	97,626	462	98,088	6,453	....	6,453	104,451
1915	58,226	11,916	70,142	1,758	2,212	3,970	74,112
1916	111,516	17,905	129,421	....	....	5,580	135,001
1917	115,705	23,938	139,643	3,658	8,100	11,758	151,401
1918	67,063	40,981	108,044	14,704	1,960	16,664	124,708
1919	94,981	61,783	156,764	6,391	30	6,421	163,185

By far the greater part of the orders for 1919 were from private car lines. It is pleasing to note in connection with the 1920 totals, that, although the orders from private car lines are practically twice the 1919 figures, the railway orders are nevertheless much larger than those from the private buyers.

The export orders for 1920 are more than twice the total for 1919, but far below the average for the preceding four years. This falling off may be explained in the same manner as was the decline in locomotive orders from abroad, i. e., the premium on the dollar in foreign countries, the return of foreign manufacturers into active competition and the generally impoverished condition of buyers throughout the world.

Freight car production in the United States during 1920 for domestic service was 60,955 and for export 14,480, making a total of 75,435 cars built in the United States during the year. The totals for 1915 only in recent years are lower than those for the past year. This decline in production is but the natural outcome of the few orders placed during 1919. The heavier orders during 1918 gave 1919 an excellent showing from the standpoint of production in spite of the fact that the orders during 1919 were much lower than usual.

The production for export in 1920—14,480—represents a decline of more than 75 per cent over the 1919 figures. The production for export in 1919 bore a large ratio to the total production and the domestic orders a small ratio to the total. This condition has not obtained during the year just past and indeed the small total for export may well occasion some concern. It is true that foreign buyers are not acquiring new equipment in anything like the quantities which they actually require, but it is also evident that manufacturers abroad are once more directing their efforts toward regaining the markets lost to American concerns during the war and that the premium on the dollar gives them an opportunity in many cases to underbid American manufacturers.

In addition to the number of cars built and ordered during the year the Railway Age also asked the manufacturers for details regarding the type of cars built. The following details concerning the construction of cars built in the United States may be of interest. All-steel, 34,140; steel frames only, 6,537: steel underframes only, 22,862; steel center sills only, 635; all-wood, 2,451; not specified, 8,810.

If the orders for the preceding year are any measure of production for the following year, and it would seem that they are, the production in 1921 should greatly exceed the 1920 total. Orders in 1918 were comparatively high and production in 1919 was high. Few orders in 1919 resulted in low production totals for the past year. In like manner, then, orders having increased greatly in 1920, production in 1921 should show considerable advances. It is well to point out in this connection that the greater part of the orders for cars in 1920 were placed in the earlier part of the year but that conditions of transportation were such and raw material so difficult to secure that the manufacturing plants are only now getting up to anything like capacity production. The output of the car building companies has averaged only 3,000 cars a month for the greater part of the year. In October and November it reached 6,000.

* * *

Photo from Keystone View Co., Inc., of N. Y.

Railroad Through a Coffee Plantation

Car and Locomotive Prices Reached Peak in 1920

Equipment Ordered During Year Cost Two and One-Half to Three Times 1910-1914 Average

THOSE railroads that purchased locomotives in 1920 paid prices for them averaging about two and one-half times the pre-war prices. The prices of freight cars were even higher in proportion than this, all-steel cars being priced at three times the pre-war figures and cars of composite construction at more than three times the pre-war prices.. The increase in passenger car prices was not as pronounced, the 1920 values having been slightly over twice the 1910 to 1914 average. These are the principal facts brought out by a study of equipment prices recently conducted by the Railway Age.

TABLE I—COMPARISON OF PRICES OF EQUIPMENT, BASED ON DATA RECEIVED FROM SIX PRINCIPAL EQUIPMENT COMPANIES IN THE UNITED STATES, USING THE WEIGHTED AVERAGE PRICE OF 1910 TO 1914 AS 100 PER CENT OR "BASE"

		Freight cars			Passenger Coaches		
Prices as sold 1910-14, inclusive. Year or period	Locomotives 147.7096 dollars per ton Per cent	All steel 2.57 cents per pound Per cent	Composite wood and steel 2.51 cents per pound, Per cent	All wood 2.26 cents per pound. Per cent	All steel 11.24 cents per pound. Per cent	Composite wood and steel 9.91 cents per pound. Per cent	All wood 9.22 cents per pound Per cent
1910-1914, inclusive. Base	100	100	100	100	100	100	100
1910	98	104	105	102	115	105	106
1911	98	89	92	96	95	106	90
1912	100	93	98	102	93	91	108
1913	107	110	113	93	98	96	107
1914	93	97	94	100	96	100	...
1915	100	102	101	93	82	...	.
1916	143	156	146	141	106	...	.
1917	210	199	169	201	132	...	.
1918	206	247	253	...	163*	...	...
1919	212	...	...	...	199*	...	...
1920 (first six mon'hs)	251	300	313	...	218	...	...

*Car companies report no steel passenger coaches contracted for in 1918 and 1919. Per cents for 1918 and 1919 estimated by car companies.

Detailed figures are given in this article showing this price relationship as between 1920 and the pre-war period.

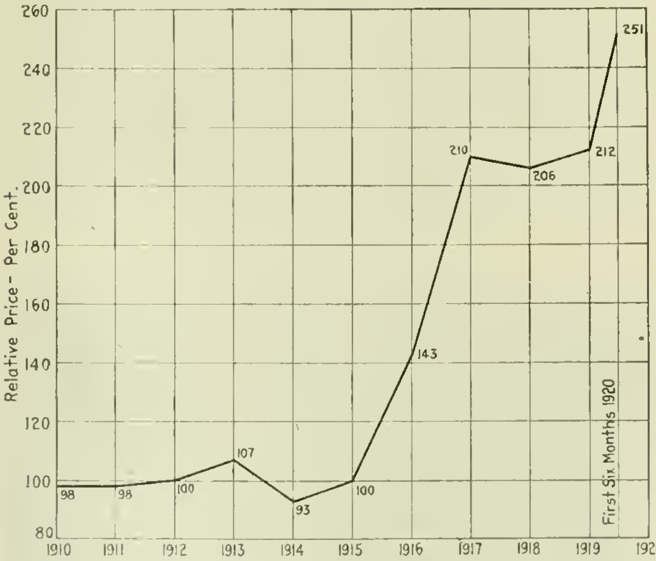


Fig. 1—Relative Prices of Locomotives 1910 to First Six Months of 1920 Shown in Terms of Average Prices 1910-1914 as 100

There is also given a table showing the prices paid for the U. S. R. A. standard equipment allocated to the railroads and, what is more important, data showing the prices which have been paid by a number of railroads for equipment which they have ordered in 1920. For purposes of showing more particularly the price trend during the year, there are also shown details of the prices of the basic iron and steel commodities which enter into the manufacture of all types of railway motive power and rolling stock.

Table I is a chart compiled for valuation purposes by the President's Conference Committee on Federal Valuation. The chart represents careful studies made by the engineers of that organization in co-operation with the equipment builders. The studies cover 10½ years, and to derive the figures shown, data were assembled covering the prices of 10,500 locomotives, nearly 275,000 freight cars and some 1,600 passenger coaches. The prices in all instances were "as sold" and cover the date of sale, not the date of delivery. The base price of 100 in the chart is taken for the period 1910 to 1914, both inclusive. The comparative percentages are worked out for the years 1910 to 1919 and for the first

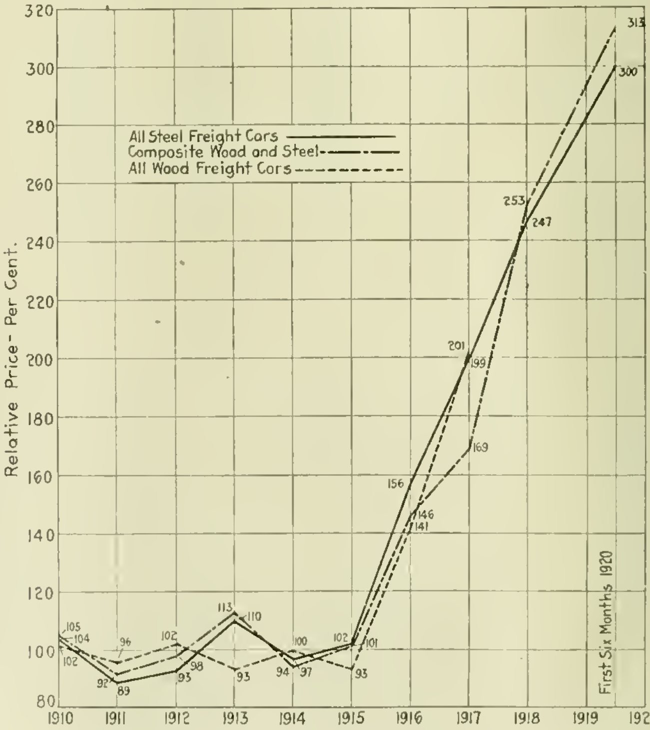


Fig. 2—Relative Prices of Freight Train Cars, 1910 to First Six Months of 1920 Shown in Terms of Average Prices 1910-1914 as 100

six months of 1920; the last figures are the ones of chief interest in this connection. The prices for the first six months of 1920 are given in the following percentages of the 1910-1914 base price:

Locomotives	251
Freight cars:	
All-steel	300
Composite	313
Passenger coaches	218

In using the figures for the first six months it must be borne in mind that approximately two-thirds of all the orders placed during the year were placed before July 1. The price trend for the year was slightly upward from January to May or June. It then ran on a level to about the latter part of October, and since that time it has fallen to slightly below the January figure. In view of these facts, and that but few orders have been placed in the last three months, it is apparent that the percentages given for the first six months are quite representative of the greater part of the orders placed for the entire year.

Table II giving the prices paid, or to be paid when finally ascertained, for the allocated U. S. R. A. standard equipment, needs but little comment. These prices are those set in connection with the equipment trust agreement made last spring to finance these cars and locomotives. They are, of course, for the year 1918, that being the year in which the orders were placed. It is interesting to note in this connection that Table I shows no freight car percentage for 1919, no orders having been reported for that year in the valuation studies.

Table III gives in detail the prices paid per unit for a large proportion of the cars and locomotives, orders for which were placed during 1920. The information is made available this year for the first time through the publicity given applications of the carriers for loans from the revolving fund or in the case of the approval by the Interstate Commerce Commission of issues of equipment trust certificates. The carriers show in their applications the details of the expenditures which the loan or equipment trust issue covers. The commission has adopted a policy of making this information public when its action, favorable or otherwise,

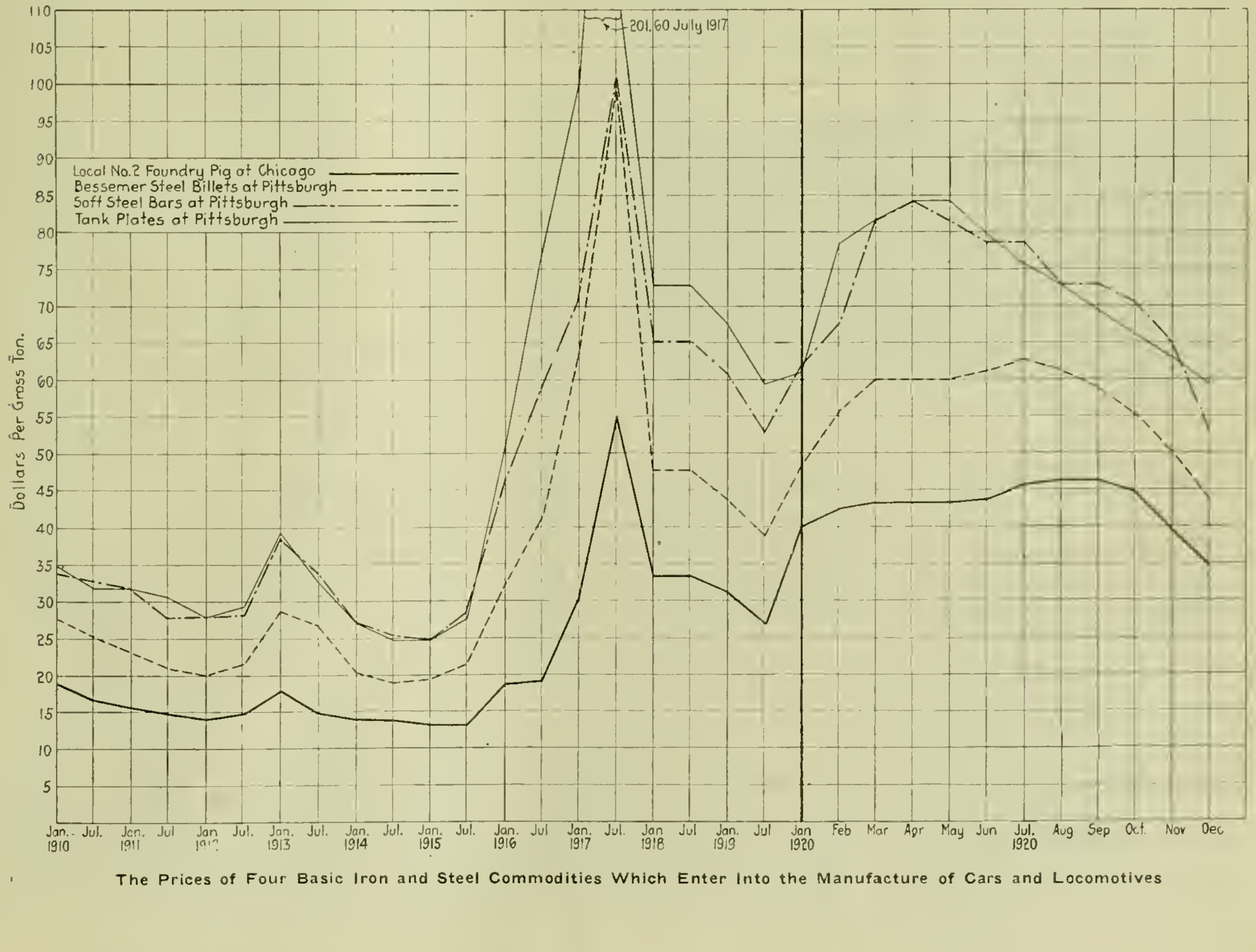
TABLE II—PRICES OF U. S. R. A. STANDARD AND OTHER ALLOCATED EQUIPMENT

Type	Capacity	Construction	Maximum price	Minimum price
Sgle. sh. box	100,000	St. frame	$3,072.45	$2,815
Dble. sh. box	80,000	St unf.	2,932.40	2,725
Hopper	110.000	Steel	2,829.32	2,505
Gondola	100,000	Comp.	2,745.01	2,645
L. S. gondola	140,000	Steel	3,212.85	3,100
P. R. R. hopper	140.000	Steel	*3,488.00	......

LOCOMOTIVES

Type	Weight lb.	Maximum price	Minimum price
Lt. Mikado	290,800	$53,556	$49,400
Hvy. Mikado	320,000	58,529	51,850
Lt. Mountain	320,000	56,995	55,000
Hvy. Mountain	352,000	61,782	55,700
Lt. Pacific	270,000	51,200	49,575
Hvy. Pacific	300,000	54,025	52,300
Lt. Santa Fe	352,000	62.003	55,975
Hvy. Santa Fe	390,000	67.317	60,450
Lt. Switch (0-6-0)	165,000	36.019	31,675
Hvy. Switch (0-8-0)	214,000	43,912	37,750
Lt. Mallet (2-6-6-2)	440,000	78,322	71,650
Hvy. Mallet (2-8-8-2)	540,000	91,958	81,575
30 P. & R. Consol	......	59.029	51.678
26 B. & O. Mallet	......	87,830	83,400
11 C. of N. J. Mikado	......	60.529	53,500
3 K. C. S. Pacific	......	*51.000	......
7 T. & P. Pacific	......	*52,955	......
16 T. & P. Santa Fe	......	*59,914	......
2 T. & P. Santa Fe	......	*59,089	......
5 Ft. W. & D. C. Pacific	......	*50,298	......

* Flat price.



The Prices of Four Basic Iron and Steel Commodities Which Enter Into the Manufacture of Cars and Locomotives

TABLE III—EQUIPMENT ORDERED IN 1920

Locomotives

					Price	
Road	No.	Type	Weight	Builder	Each	Total
Ann Arbor	3	0-8-0	200,000	American	38,925	116,775
Atlantic Coast Line	25	4-6-2	277,000	American	57,407	1,435,175
	5	0-6-0	163,600	Baldwin	47,600	238,000
Baltimore & Ohio	50	2-8-2	300,000	Baldwin	84,000	4,200,000
Bangor & Aroostook	6	2-8-0	211,000	American	60,000	360,000
Central of Georgia	7	4-8-2	316,000	American	67,857	475,000
Chesapeake & Ohio	20	2-6-6-2	441,000	American	89,990	1,799,800
	5	0-10-0	295,000	American	63,650	318,250
Chicago & North Western	40	2-8-2	302,000	American	73,413	2,936,520
	20	4-6-2	260,000	American	66,625	1,332,500
Chicago Great Western	10	2-8-2	284,400	Baldwin	55,200	552,000
Chicago, Rock Island & Pacific	15	2-10-2	383,000	American	78,673	1,180,085
	10	2-8-2	327,000	American	66,705	667,050
	10	4-8-2	340,000	American	70,103	701,030
Chicago, St. Paul, Minneapolis & Omaha	6	2-8-2	320,000	American	72,450	434,700
	4	0-6-0	164,000	American	46,400	185,600
Cleveland, Cincinnati, Chicago & St. Louis	10	0-8-0	217,000	Lima	47,559	475,592
	10	4-6-2	282,000	American	58,380	583,800
	50	2-8-2	328,000	American	68,040	3,401,968
Great Northern	45	2-8-2	320,000	Baldwin	51,111	2,750,000
Illinois Central	50	2-10-2	380,000	Lima	87,700	4,385,000
	25	4-6-2	278,000	American	64,925	1,623,125
Michigan Central	6	0-8-0	217,000	Lima	47,300	283,800
	10	4-6-2	282,000	American	58,340	584,000
	10	2-8-2	328,000	American	69,251	692,505
Minneapolis & St. Louis	15	2-8-2	262,000	American	64,365	965,475
New York Central	50	0-8-0	217,000	Lima	47,328	2,366,400
	20	4-6-2	282,000	American	58,440	1,166,800
	10	2-6-6-2	364,000	American	82,400	824.000
	3	0-8-8-0	468,000	American	92,000	276,000
Northern Pacific	6	2-8-8-2	476,000	American	101,964	611,785
	20	4-6-2	296,000	American	70,444	1,408,878
	25	2-8-2	335,000	American	73,370	1,834.215
	24	0-8-0	214,000	American	51,748	1,241,953
Southern Pacific	2	Electric	......	Bald. West	42,500	85,000
Western Maryland	20	2-8-0	296,000	Baldwin	75,000	1,500,000

Freight Cars

						Price	
Road	No.	Type	Capacity, lb.	Construction	Builder	Each	Total
Atchison, Topeka & Santa Fe	500	Gondola	100,000	St. fr.	Am. C. & F.	3,003	1,501,500
	1,250	Refrig.	80,000	St. unf.	Am. C. & F.	4,750	11,875,000
	1,250	Refrig.	80,000	St. unf.	Has. & Bar.		
Atlantic Coast Line	100	Phosphate	......	St. unf.	....	2,960	296,000
	500	Vent. Box	80,000	St. unf.	Std. Steel	3,718	1,859,090
	400	Hopper	100,000	Steel	Std Steel	3,021	1,208,364
	100	Phospbate	......	St. unf.	....	3,324	332,466
Baltimore & Ohio	1,000	Box	80,000	St. unf.	Mt. Vernon	2,629	2,629,000
	1,200	Hopper	100,000	Steel	Pressed St.	1,919	2,302,800
	500	Refrig.	70,000	St. unf.	Am. C. & F.	2,800	1,400,000
Central of Georgia	100	Stock	......	St. unf.	....	2,500	250,000
	500	Vent. box	......	St. unf.	....	3.000	1,500,000
	200	Gondola	......	St. fr.	....	2,800	560,000
Chesapeake & Ohio	1,000	Gondola	200,000	Steel	500 Pr. St. 500 Std. St.	6,000	6,000,000
Chicago, Rock Island & Facific	50	Caboose	......	St. unf.	Std. Steel	4,464	223,200
	500	Gondola	......	......	Bettendorf	3,300	1,650,000
Chicago & North Western	500	Ore	100,000	Steel	Fullman	2,284	1,142,000
	500	Stock	80,000	St. unf.	Gen. American	2,605	1,302,500
	250	Refrig.	80,000	St. unf.	Am. C. & F.	4,872	1,218,000
	50	Caboose	......	St. unf.	Am. C. & F.	4,112	205,600
Cleveland, Cincinnati, Chicago & St. Louis	500	Box	100,000	Steel	Std. Steel	3,662	1,830,760
	500	Auto	100,000	Steel	Has. & Bar.	3,722	1,860,760
	1,750	Hopper	110,000	Steel	Am. C. & F.	2,577	5,154,100
	250	Hopper	110,000	Steel	Std. Steel		
	100	S. d. Stock	80,000	St. unf.	Has. & Bar.	2,950	295,000
Great Northern	500	Ore	150,000	Steel	Am. C. & F.	2,540	2,540,000
	500	Ore	150,000	Steel	Has. & Bar.		
Illinois Central	1,000	Refrig.	60,000	St. unf.	Pullman	4,255	4,255,000
	200	Flat	100,000	Steel	Bettendorf	2,370	474,000
	300	Stock	80,000	St. fr.	Am. C. & F.	2,920	876,000
	50	Caboose	......	......	Freese & Swenson	3,000	150,000
Michigan Central	1,000	Auto	100,000	Steel	Am. C. & F.	3,722	3,721,520
	500	Hopper	110,000	Steel	Pressed Steel	2,577	1,288,675
	100	S. d. Stock	80,000	St. unf.	Has. & Bar.	2,950	295,000
	100	D. d. Stock	80,000	St. unf.	Has. & Bar.	3,125	312,500
	250	Refrig.	69,000	St. unf.	Mer. Des.	4,008	1,002,000
Minneapolis & St. Louis	500	Box	......	......	....	3,000	1,500,000
	500	Gondola	......	......	....	2,800	1,400,000
	200	Refrig.	......	......	....	3,800	760,000
New York Central	1,000	Box	100,000	Steel	Std. Steel	3,660	3,660,000
	750	Auto	100,000	Steel	Am. C. & F.	3,720	3,720,000
	250	Auto	100,000	Steel	Std. Steel		
	1,500	Hopper	110,000	Steel	Std. Steel	2,443	3,664,000
	494	S. d. Stock	80,000	St. unf.	Mer. Des.	2,930	1,457,200
	200	D. d. Stock	80,000	St. unf.	Has. & Bar.	3,122	624,500
Northern Pacific	300	Hart. conv.	100,000	St. fr.	Am. C. & F.	3,745	1,123,374
	60	Air dump	......	......	....	5,000	300,000
	100	Caboose	......	St. center sills	Pac. Car. & Fdy.	3,500	350,000
	1,000	Box	......	St. unf.	....	2,500	2,500,000
Southern Pacific	2,000	Box	80,000	......	Co. Shops	3,200	6,400,000
	1,000	Flat	100.000	......	Co. Shops	2,400	2,400,000
	1,000	Stock	80,000	......	Co. Shops	2,750	2,750,000
	500	Auto	100.000	......	Std. Steel	3,310	1,655.000
	250	Ballast	100,000	......	Mt. Vernon	3,682	920,500

Passenger Cars

					Price	
Road	No.	Type	Construction	Builder	Each	Total
Atlantic Coast Line	25	Coaches	Steel	Pullman	$34,036	$850,905
Chicago & North Western	25	Coach	Steel	Am C. & F.	26.771	669,275
	9	Smoking	Steel	Am. C. & F.	25,979	233,811
	2	Postal	Steel	Am. C. & F.	27,500	55,000
	23	Baggage	Steel	Am. C. & F.	22,000	506,000
	3	Mail and Baggage	Steel	Am. C. & F.	27,500	82,500
Illinois Central	20	Suburban	Steel	Pullman	29,880	597,600
	12	Compartment	Steel	Pullman	36,539	438,468
	18	Baggage	Steel	Pullman	26,650	479,700
	5	Dining	Steel	Fullman	51,005	255,025

is announced; the information, however, is not available before that action is announced.

The details given vary in nearly every case, depending upon conditions. In compiling the data given herewith, the information made available by the commission has been supplemented by details obtained from other sources. Thus in the usual instance the road shows the number of locomotives (or cars) involved, the type and the total cost of the equipment of that particular type. For instance, a road may indicate that it desires to finance the purchase of 10 Mikado locomotives at a total cost of $800,000, and 10 Pacific locomotives at a total cost of $680,000. From this it is evident that the Mikado locomotives will cost $80,000 each and the Pacifics $68,000 each.· If the order has already been placed, this information has been supplemented from our own records with the name of the builder and the total weight in working order.

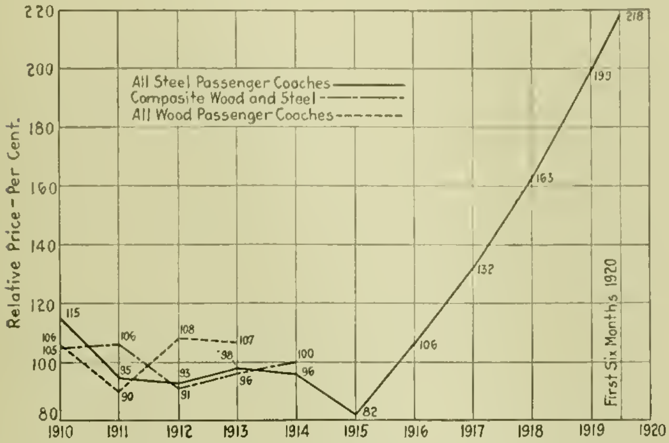


Fig. 3—Relative Prices of Passenger Coaches, 1910 to First Six Months of 1920 Shown in Terms of Average Prices 1910-1914 as 100

TABLE IV—IRON AND STEEL PRICES

	Local No. 2 Foundry pig at Chicago, per gross ton	Bessemer steel billets at Pittsburgb, per gross ton	Soft steel bars at Pittsburgh, cents per lb.	Tank plates at Pittsburgb, cents per lb.
1910, January	19.00	27.50	1.50	1.55
July	16.56	25.00	1.45	1.41
1911, January	15.50	23.00	1.40	1.40
July	14.87	21.00	1.23	1.35
1912, January	14.00	20 00	1.15	1.15
July	14.70	21.50	1.25	1.30
1913, January	17.90	28 30	1.70	1.75
July	14.70	26.60	1.50	1.45
1914, January	13.75	20.13	1.20	1.20
July	13.75	19.00	1.12	1.10
1915, January	13.00	19.25	1.10	1.10
July	13.00	21.38	1.25	1.22
1916, January	18.50	32.00	2.03	2.25
July	19.00	41.00	2.63	3.44
1917, January	30.00	63.00	3.15	4.45
July	55.00	100.00	4.50	9.00
1918, January	33.00	47.50	2.90	3.25
July	33.00	47.50	2.90	3.25
1919, January	31.00	43.50	2.70	3.00
July	26.75	38.50	2.35	2.65
1920, January	40.00	48.00	2.75	2.72
February	42.25	55.25	3.00	3.50
March	43.00	60.00	3.63	3.63
April	43.00	60.00	3.75	3.75
May	43.00	60.00	3.63	3.75
June	43.40	61.00	3.50	3.55
July	45.25	62.50	3.50	3.38
August	46.00	61.00	3.25	3.25
September	46.00	58.74	3.25	3.25
October	44.50	55.00	3.13	3.09
November	39.40	49.70	2.87	2.81
December	34.50	43.50	2.35	2.65

The data in the case of freight cars are similarly compiled, except that instead of total weight the details given relate to the capacity and class of construction. In the case of passenger cars the class of construction is given.

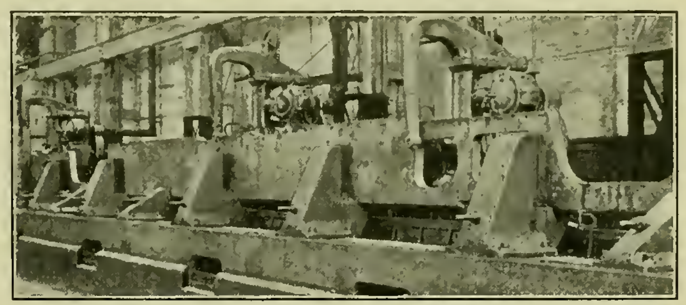
The feature concerning prices that is probably most important at the present moment is the trend of prices. It has been difficult to secure definite details as to the prices which have been paid for equipment ordered in the last month or two, one of the reasons being that details are not yet available for the public, the other and equally important reason being that so few orders have been placed. It is for this reason primarily that there are introduced in Table IV the relative prices of several basic iron and steel commodities which enter into car and locomotive manufacture. These prices have also been platted on a diagram, but, however they are shown, the rise to the peak in the early months of the year and the rapid decline in the latter months are plainly indicated. The prices of cars and locomotives presumably do not vary exactly with these commodity prices, but the lag behind them is not great. Investigation shows that car and locomotive prices have shown a decline in the last month or two. They are now approximately 10 per cent below the peak prices of the year.

Three Column Frame Milling Machine*

In Germany many locomotive frames are now made from plates, the full width of the frame section, rolled in armor plate mills. The recesses are cut out either by the oxy-acetylene torch or by machining. After cutting out with the torch, the frames are finished on the familiar type of slotting or milling machine.

The autogenous cutting process, however, is expensive and changes the quality of the material in proximity to the cut. For these reasons a firm of German machine tool builders has designed the interesting three column milling machine illustrated. The locomotive frames are clamped to heavy angle blocks rigidly fastened to the foundation shown. Suitable webs are cast to the angle blocks so that they are not in the way of the mechanic during the work and do not need to be shifted in the course of the operation.

Three milling columns are provided, entirely independent of each other and moving on common ways. Each has a horizontal milling spindle. Levers and hand wheels for the operation and control of the machine are arranged so that the entire machine may be conveniently operated from one central platform.



Three-Column Frame Milling Machine

Below the frame to be finished there is a templet which in the natural size shows the shape of the section to be milled. A copying roller fastened to the slide rest of the milling machine runs in the slot of the templet. The vertical and transverse feeds of the column and the slide rest with the milling cutters are thus mechanically controlled by the copying roller. For introducing the milling cutter into the frame recesses, the machine itself is arranged to drill the necessary holes.

The milling cutters are permanently cooled by water which returns to a water tank provided in the concrete foundation of the machine, a perforated sheet iron plate retaining all chips. The machine is stated to be capable of accurate work and high production.

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*Abstract from an article in the December issue of Engineering Progress, entitled Milling Machine for Locomotive Frames.

Increasing the Capacity of Old Locomotives*

Suggestions for Modernizing Old Locomotives and the Possibilities of This Development

BY C. B. SMITH
Mechanical Engineer, Boston and Maine

IN these days of the high cost of railroading, responsible officers of the mechanical departments realize that the necessity for reducing the cost of all locomotive operation and maintenance is more urgent than ever. Such saving can be accomplished in two ways, one by using new and modern locomotives, the other by rebuilding old types.

On the majority of our roads there are still locomotives of the earlier modern types whose general features of construction are satisfactory, and which only require modernizing to make them economical transportation units. Improvements for such classes of locomotives may include, in addition to superheaters, piston valves in place of slide valves, outside valve gears in place of Stephenson motion, and such other improvements as are usually made upon engines at general shoppings.

When setting out to rebuild a locomotive the experienced supervisor appreciates the opportunity to apply many devices and facilities which will standardize the engine in accordance with the railroad company's practice, and in so doing, reduce repairs and stores department expense in maintenance.

The aggregate of such improvements results in a locomotive which in proportion to its capacity will produce service results comparable with those of entirely modern construction, and at a cost approximately one-half that for a new locomotive of similar capacity. The difficulty in carrying forward an extensive reconstruction program, however, is in finding the shop facilities either on the railroad or among the locomotive builders in order to advance the work at a satisfactory rate of progress. Despite this difficulty the results which could be obtained from the operation of reconstructed locomotives, if they could all be rebuilt within the next few years, would justify a special effort on the part of railroad managements to bring it about.

On roads where the number of old locomotives which warrant rebuilding is sufficient to require a period of more than three years to complete the work, it would seem necessary to arrange for enlargement of shop facilities in order to hasten the reconstruction. If, however, adequate shopping facilities are not forthcoming, the improvement program for locomotives must be confined chiefly to the application of superheaters and the substitution of piston for slide valves; together with the minor but relatively important betterments that may usually be applied at the shopping period. On some roads this work alone will require six years at the present rate to equip what can rightly be called the "early-modern" locomotives.

Some of the engines built within the past ten years have developed weaknesses in frames and in parts of running gear. It has proved justifiable to reconstruct them by substituting new parts of stronger design and thus avoid recurring breakages which interrupt both the road service of these engines and the repairs to others. On roads whose traffic and service conditions now demand and will continue to demand the use of light locomotives for passenger trains and freight trains on branch lines, the better classes of the light locomotives should also receive their share of improvements along with the heavier power.

Old locomotives requiring new boilers have very generally been scrapped, but where light train service demands no heavier engines than formerly, the writer believes it advisable to rebuild such engines with radial-stay boilers, superheaters, new piston-valve cylinders, main frames when necessary, and outside valve gears. If there is to be no increase in the boiler pressure over that formerly carried by the locomotive and the valve motion has given little trouble by breakages, the Stephenson motion may be connected to the piston valves through the usual rocker-shaft connections.

When rebuilding locomotives there is a favorable opportunity for replacing old tenders as well, transferring the latter to older locomotives for spare use or as substitutes for damaged equipment. When the condition of old steel tender frames requires that they be replaced, the one-piece steel casting and a larger-capacity tank should be used, as both will reduce future expense in repairs. The success of autogenous welding eliminates any objections to the use of large steel castings for fear of breakages.

Tanks should be reconstructed in coal space to permit gravity delivery of the greatest amount of fuel that is possible at the coal gates within reach of the fireman's shovel. Application of power-operated coal pushers should be made to tanks where alterations for the gravity delivery of coal cannot be satisfactorily made and where the service conditions will show a saving in expense by its use over hand methods of shoveling forward coal while on the road or at short lay-over stations.

Discussion

The discussion following the presentation of this paper at the recent meeting of the Railroad Section of the American Society of Mechanical Engineers was unusually broad and comprehensive. Through the efforts of the committee on meetings and papers, some of the best authorities on this subject had been engaged to participate in this discussion. The first to speak in regard to increasing the capacity of old locomotives was Frank McManamy, now assistant director-general of railroads. Without going into all of the details relating to those features essential to increasing the capacity of old locomotives, Mr. McManamy outlined some of the conditions essential to the successful modernization of power. It was pointed out that the value of any specialty applied for the purpose of increasing the capacity of old locomotives would be nullified unless the railroads possess a trained organization and adequate facilities for the proper maintenance of these appliances. The application of such appliances was strongly endorsed by Mr. McManamy, who claimed the credit for the liberal modernization program undertaken during the period of federal control.

The application of the superheater, the stoker and the feedwater heater were commented upon as among the best measures toward modernization, but with the application of these, as with other devices, intelligent handling and adequate maintenance are essential before they can be of any real value. The simple application of these devices is not sufficient; they must be properly used and adequately maintained. In view of this fact Mr. McManamy believes that the improved locomotive terminal is, in fact, the key to the

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*Abstract of a paper presented at the Railroad Section of The American Society of Mechanical Engineers on December 8, 1920.

situation. So many complicated specialties are now being applied to locomotives that it is now common to refer to these locomotives as being "full-jewelled," and in many instances the application of these specialties has proved a detriment because the railroads did not have adequate terminal facilities to insure their maintenance.

In a written discussion of the subject submitted by W. O. Moody, mechanical engineer of the Illinois Central, the necessity for adequate shop, as well as locomotive terminal facilities, was emphasized. Mr. Moody pointed to the fact that in the absence of shop facilities adequate for current maintenance of locomotives, little could be hoped for toward the modernization of locomotives upon any considerable scale. In this connection it should be remarked that the locomotive companies which, until recently, have been busily engaged on new locomotive construction, are now in a position to undertake considerable modernization work for the railroads, and in view of the possibilities in this direction it would appear to be an opportune time for the railroads to assign some of this work to the locomotive builders, where they are unable to undertake it in their own shops and are not justified in the purchase of new locomotives.

Mr. Moody spoke of the locomotive booster as one of the most promising appliances designed to increase the capacity of old locomotives. It is believed that any comprehensive plan of modernization should include consideration of the booster. It was also pointed out that the modernization of locomotives offered an excellent opportunity for the further standardization of parts to such an extent as would permit a considerable reduction in the number of parts that must be carried in stock to protect the locomotives in service. Any reduction of this character should be welcomed as a means for reducing overhead charges.

J. C. Hassett, mechanical engineer of the New York, New Haven & Hartford, also advocated the modernization of old locomotives as a means to increase their capacity and laid particular stress upon the necessity for strengthening locomotive frames in connection with this development. Some interesting facts in connection with this work as undertaken on the New Haven were described by Mr. Hassett, who said that it had been found necessary to materially strengthen the frames of certain locomotives before they could be modernized and that this had also resulted in improving their riding qualities as well as increasing their capacity.

Forceful Arguments for Feed Water Heating

Some strong arguments in favor of locomotive feed water heating were presented by E. A. Averill, vice-president of the Locomotive Feed Water Heater Company, who contributed to the discussion as follows:

"Increasing the capacity of all old or semi-modern locomotives, whenever increased capacity can be used and increasing the efficiency of those which are in a service where increased capacity will not show a return, should be the first feature to be investigated and carefully analyzed.

"You will be astonished at the returns that can be obtained in investments made to this end. As an example of what can be accomplished on even some of the more modern locomotives, built within the last six or eight years, let me quote the results recently obtained from road tests with a locomotive feed water heater which is one of the appliances mentioned in this paper. These tests were made on three different railroads and each was as carefully conducted as is possible with tests made in regular operation. On the first road, the test showed a saving, due entirely to the appliance being investigated, of $252 a month, based on coal costing $5 a ton. On the second road, the direct saving was $233 a month, and on the third it was $226 a month. This is an average for the three roads of $237 saved per month per locomotive.

"Do you not think that a net saving of over $200 a month from each locomotive will make a welcome addition to the net operating income of any railroad? The feed water heater is applicable to all kinds and classes of locomotives at a moderate expense and offers one of the quickest and most positive methods by which the capacity of a locomotive can be largely increased. It has the further advantage of not requiring any additional shop facilities for its extensive application. From the standpoint of the motive power department doing its full share towards making visible the net profits of a railroad, I would recommend a thorough study of feed water heating to be placed near the top of the list of things to be considered.

"It may interest you to know that feed water heaters, which will raise the temperature of the water from 40 deg. or 50 deg. to from 230 deg. to 250 deg., have been in successful railroad service for over three years. Furthermore, these heaters filter all the water formed from the condensed exhaust steam and return it, free from oil, to the tender. This adds about 14 per cent to the capacity of the tender and greatly extends the distance that can be made between stops for water.

"On most locomotives an increased boiler capacity can be fully used in regular service and furthermore since any boiler is most economical and most efficient at its lower rates of working, an appliance which makes the boiler larger always shows returns. It gives the increased capacity when it is needed and it gives greater efficiency when the larger capacity cannot be used. A feed water heater lies entirely in this class of equipment. It permits the boiler to deliver 9 lb. of steam for each pound of coal burned where, without the heater, it would deliver about 7.8 lb. of steam for each pound of coal. If, however, service conditions were such that only the smaller quantity of steam could be employed, a boiler equipped with a feed water heater would be operating at 65 per cent efficiency, as compared with 61 per cent for the same quantity of steam, without the heater, and thus this appliance is giving a return of one sort or another at all times.

"I have mentioned the fact that there is a return to the tender of 14 per cent of distilled and filtered water, and inasmuch as any study of increased locomotive capacity must be based on a consideration of the locomotive as a producer of economical transportation, this feature, many times, is found to be one of great importance. The ability to continue the train in operation past a water station, where it would have been compelled to stop if not equipped with a feed water heater, frequently means a difference of hours in the arrival of the train at the terminal and a very large saving of overtime wages and loss of service of the locomotive. Again this feature at periods of congested traffic frequently permits the despatcher to keep everything moving on the division and opens up the possibility of very large returns from this cause alone. Where feed water heaters have been applied to locomotives, it is almost universal that the train despatcher is one of the strongest advocates of a heater on an engine."

Superheat as a Means to Increased Capacity

In commenting on the subject of increasing the capacity of old locomotives, H. B. Oatley, chief engineer of the Locomotive Superheater Company, took this opportunity of bringing out, somewhat in detail, the features which have prompted the very extensive superheating programs which have been in vogue on many of the railroads for a considerable period. A table presented by Mr. Oatley gave some comparisons between saturated and superheated locomotives. The locomotives considered were typical of each class. The cylinders, boiler pressure and maximum tractive power were shown as being the same for both the saturated and superheated steam conditions, although many engines have had the tractive power increased when superheaters were applied, under the conditions referred to later. .

"By the addition of a high degree superheater," Mr. Oatley said, "it has been demonstrated that the steam consumption per horsepower hour is reduced about 28 per cent. The figures commonly accepted as representing good practice are 27 lb. for saturated steam and 19.5 lb. for superheated steam. In the case of the 0-6-0 type boiler, the horsepower has been increased 15 per cent; for the 4-4-0 type 14 per cent; for the 2-6-0 type 13 per cent; for the 2-8-0 type 10 per cent, and for the 4-4-2 type 10.2 per cent. The maximum cylinder horsepower, using the American Locomotive Company's figures, has, by the addition of a superheater, been increased about 8 per cent.

"The ratio between boiler horsepower and cylinder horsepower, therefore, has been improved. When consideration is also given to the fact that a boiler with a superheater is at a greater advantage when worked under high rates of evaporation, for the reason that the degree of superheat increases under such conditions, the marked improvement is evident. It is very clear that the additional boiler capacity afforded by the addition of the superheater should, if possible, be utilized by providing greater maximum tractive power. When considering existing locomotives the increase in the maximum tractive power requires consideration of, 1st. The factor of adhesion. 2nd. The strength of the running gear which has to withstand the thrust of the piston.

"As in all other problems, the cost of making improvements must be balanced against the advantages which can be realized. For example: if the engine at the present time has adequate power for the work which is to be done, the expense in providing additional power would not be justified. Such cases are, however, believed to be rare, as the very large majority of existing locomotives are for all or a part of their working time required to handle every ton behind the tender that they will move. If the factor of adhesion and the strength of the parts taking piston thrust are such that an increase in cylinder tractive power can be utilized, such additional power may be attained by, 1st. Increasing boiler pressure. 2nd. Increasing cylinder diameter.

"If the amount that the maximum tractive power can be increased effectively is greater than can be obtained by boring existing cylinders, or by increasing boiler pressure, or a combination of the two, the use of new cylinders should be carefully considered. If new cylinders are applied a cylinder diameter should be selected which would permit the utilization of pistons, cylinder heads, steam chest covers, etc., and, if possible, cylinder patterns which are in use on other classes of engines on the road. It is many times found that a cylinder diameter can thus be selected which will give the desired increase in tractive power, even with a decreased boiler pressure. A decrease in boiler pressure in very many instances, particularly on the older boilers, is especially attractive, as such boilers are frequently of an age and condition which would in any event require either scrapping or operating at a lower pressure.

"Many instances will be found where for one or another of the conditions already mentioned, an increase of cylinder diameter above that which is obtainable by boring will not be advisable, and if, in such cases, slide valves are existent on the engine in question, the application of superheaters need not be foregone, as the use of piston valve steam chests fitted to existing slide valve seats has demonstrated its practicability and economy."

A Critical View of the Situation

In his remarks on the subject of increasing the capacity of old locomotives, J. T. Anthony, vice-president of the American Arch Company, stated that with 65,000 locomotives in service on American railroads, only 35,000 are equipped with superheaters; 43,000 with arches; 37,000 with automatic fire doors; 15,000 with power reverse gears; 2,000 with automatic driving box wedges, and only 30 with feed water heaters. The reasons commonly given for this condition, he said, "are lack of shop facilities and inability to get appropriations with which to carry on the work. But it is difficult to understand why the responsible officials who willingly make appropriations of millions of dollars for grade reductions, curve eliminations, etc., with the sole idea of increasing train loading and reducing operating expenses, should turn a deaf ear to the requests of the mechanical departments when they have the same object in view.

"The railway shop equipment is woefully inadequate at the present time; but this will not serve as an excuse for the fact that 22,000 locomotives are being operated today without brick arches. This simple device can be installed in the round-house in less than 24 hours, and its maintenance not only does not require any increase of the round-house force; but effects a reduction in boiler repairs and engine failures. Many years of use and a large number of carefully conducted tests have shown conclusively that the arch is good for a fuel saving of 7 to 14 per cent, or for an increase in boiler capacity of 8 to 16 per cent. To use a conservative figure the arch is good for an average reduction in fuel consumption of 10 per cent, or an increase in boiler capacity of 11

COMPARISON OF SATURATED AND SUPERHEATED STEAM LOCOMOTIVES OF VARIOUS TYPES

Line		4-4-0		4-4-2		2-6-0		0-6-0		2-8-0	
		Sat.	S.H.	Sat.	S.H.	Sat.	S.H.	Sat.	S.H.	Sat.	S.H.
1	Cylinders	20" x 24"		22" x 26"		19" x 26"		20" x 26"		21" x 30"	
2	Wheel diameter (drivers)	69"		80"		63"		51"		63"	
3	Boiler Pressure	190#		205#		200#		180#		210#	
4	Tractive Power (maximum lb.	22470		27470		25300		31100		37500	
5	Weight on Drivers, lb.	94000	96000	124100	126000	125500	128000	144600	147600	172500	176500
6	Factor of Adhesion	4.18	4.27	4.51	4.59	4.96	5.06	4.65	4.74	4.6	4.7
7	Heating surface, tubes sq.ft.	1957	1035	2474	1335	1732	948	1750	987	3194	1737
8	Heating surfaces, flues " "	-	402	-	506	-	392	-	412	-	650
9	Htg.surf.firebox & water tubes sq.ft.	232	232	166	166	158	158	156	156	189	189
10	Total " "	2189	1669	2640	2007	1890	1498	1906	1555	3383	2576
11	Superheating Surface " "	-	314	-	435	-	296	-	306	-	530
12	Combined Total " "	2189	1983	2640	2442	1890	1794	1906	1861	3383	3106
13	Total Water Evaporated (1) Lb.	31530	25930	32228	25728	26720	22120	28430	23610	40960	32510
14	Steam per ind. h.p. hour Lb.	27	19.5	27	19.5	27	19.5	27	19.5	27	19.5
15	Boiler Horse Power	1165	1330	1196	1320	999	1135	1052	1210	1515	1667
16	Boiler H.P. Increase %	-	14	-	10.2	-	13	-	15	-	10
17	Maximum Cylinder Horsepower (2)	1265	1369	1655	1786	1202	1300	1199	1297	1543	1667
18	% Boiler H.P. of Cylinder H.P.	92.3	97.5	72.3	74	82.9	87.4	87.7	93.2	98.1	100

(1) American Locomotive Co.'s method used but figures are those used by Locomotive Superheater Co.
(2) American Locomotive Co.'s figures used.

per cent. Under the present condition of high price of fuel each dollar invested in the brick arch for old locomotives is equivalent to at least a five dollar reduction in operating expenses.

"There are only three methods of increasing the heating surface of an existing firebox, i. e., by the installation of a combustion chamber, or arch tube, or thermic syphons. At the present time there are only 6,000 locomotives equipped with combustion chambers, and something over 100 equipped with thermic syphons, this device being of rather recent origin. Many of the existing boilers can be improved by adding combustion chambers when new fireboxes are put in, thereby increasing the firebox volume and reducing the oft-time excessive flue lengths, and in other cases new back-ends should be put on when it is necessary to renew fireboxes of narrow and antiquated designs, thereby increasing the grate area and firebox volume. Too little attention has been paid to the possibility of improvements in old boilers by these means. While it is true that the addition of superheaters and brick arches often reduces the demands made upon it, there is still a lot of room for improvement, particularly in regard to the firebox as a furnace wherein fuel may be burned efficiently. In this connection, we might call attention to the poor designs of ash-pan on thousands of our present locomotives, on many of which it is impossible to secure an adequate air supply. Such conditions can be remedied at comparatively little expense and effect a large saving in fuel.

"As a tip to the skeptics who are prone to wait for someone else to demonstrate that improvements are possible, I quote the following figures obtained from tests of Consolidation locomotives on a large western road where the operating conditions were such that the locomotives made 40,000 engine miles per year; the cost of coal being $4.50 per ton on tender, which is much below the average price at the present time.

	Annual fuel consumption per locomotive		Annual saving	
	Tons			
Saturated Consolidation without arch	7,500	$33,750	......	
Saturated Consolidation with arch	6,752	30,384	$3,366	(Saving credited to brick arch)
Superheated Consolidation with arch	4,989	22,450	7,934	(Saving credited to superheater)
Superheated Consolidation with arch and syphons	4,257	19,156	3,294	(Saving credited to thermic syphon)

"The addition of the three devices mentioned resulted in an annual saving of $14,594 per locomotive; this 44 per cent reduction in the fuel cost being accompanied by an increase of approximately 20 per cent in tonnage hauled. And this does not represent the limit to improvements, for there are other devices that might be added, and changes made that would result in still further improvements.

"In the last paragraph of his paper Mr. Smith voices the hope that the discussion at this meeting will result in outlining some practical action to be taken by the various roads to hasten the work of reconstructing old locomotives, and states that the application of all desirable auxiliaries is prohibitive without radical provision for the carrying out of such a program. We join him in that fond hope, but, in our opinion, it will be necessary to first bring about a radical change in the attitude of many railway officials before any adequate provisions for such a program can or will be made.

"The many improvements that have been made in locomotive design in the past 10 or 15 years have not come about in answer to any loud and sustained cry from the railroads for more efficient locomotives. The railroads asked for larger and more powerful locomotives; but the devices that have made the locomotives of increased capacity and efficiency possible, have been largely left to the ingenuity of the railway supply companies and, in a smaller degree, to the locomotive builders. The development of the several well-known fuel economy and capacity increasing devices has been due to the labor and efforts of men who have left the railway service, in many cases on account of the lack of interest of the railroad in the device which the individual was trying to get perfected and used.

"If we can judge the future by the past, there will be no radical provisions made for the carrying out of a locomotive reconstruction program until the officials of the mechanical and operating departments awake to a full realization of the possibilities of reducing present operating expenses by the maintenance of a high standard of efficiency of *all* their locomotives, and by their urgent demands and intelligent presentation of facts, convince the higher authorities—those who have to dig up the money—of the feasibility and desirability of such a program."

The Care of Locomotive Boilers

Some interesting observations on the care of locomotive boilers are found in a paper on Locomotive Running Shed Practice by W. G. Bishop of the South African Railways, published in the Journal of the Institute of Transport. In discussing methods of washing out engines, Mr. Bishop says "The old method of washing out boilers with cold water is so well known that its disadvantages make one surprised at the tenacity displayed in the retention of such an obsolete method. As a time and money wasting process, it would be hard to beat. To wash out a boiler with cold water will take 12 hours at least to do properly and there is always the added danger that transportation calls are so pressing, that boilers are not allowed to cool properly before cold water is admitted. This is extremely detrimental to the life of the firebox."

Mr. Bishop estimates that in a terminal handling 100 locomotives in a fair water district, the hot water washout plant would effect a saving of 3,600 engine hours each month. There is a material saving in the cost of labor for washing in using hot water and the hot water system also effects additional savings in labor and material for repairs to boilers, in fuel used for firing up and in water. In conclusion, Mr. Bishop says, "Washing out with cold water is as obsolete as the tallow candle and no railroad concerned in the movement of traffic can afford to hang up its power by continuing to use cold washouts. It is a clear loss of 20 per cent of its power at least."

Much of the water used for boiler purposes in South Africa is of very bad quality and apparently the South African Railways have experienced the same difficulties as American roads in applying water treatment, for Mr. Bishop remarks, "Very few railways ever give any system of water treatment a chance. It is the job of a highly skilled specialist, the railway chemist. Too often plants installed are looked after in some sort of manner by a mechanical officer who may make chemistry a hobby and fairly successful results are obtained. A change comes and a new man arrives who does not specialize in chemistry and the water softener falls in disuse and finally goes out of action. A large corporation should have a chemist on its staff and water treatment should be considered of the highest importance. No softening plant or boiler compound will ever be a success until it is handled on the proper lines. The effect of good water on the life of the boilers and freedom from leaks and repairs is so great that one often wonders how any road can afford to be without its water treatment section, officered by a fully qualified, analytical chemist."

IN QUENCHING TOOLS be careful to have no sharp line of demarcation between the hardened and softer unquenched sections.—*The Melting Pot.*

Reducing the Fuel Consumption of Power Plants

Methods of Increasing Boiler Efficiency; Reducing Heat Losses by Insulating Steam Pipes

BY WILLIAM N. ALLMAN

THE matter of fuel conservation is now one of the big problems of the day. Coal prices have soared and costs are considerably more than just a few years ago. It is therefore evident that the power plant engineer has to confront problems that are reaching immense proportions. In summing up the whole matter the remedy for fuel waste resolves itself into a thorough knowledge of combustion and the initiative to apply such knowledge in such a way that results will be obtained. From this it is quite evident that trained men are desired to meet the requirements of economical operation.

To waste coal is to waste money and unless all possible heat units are being obtained from the coal a part is being wasted. What goes up the chimney as smoke and what coal is thrown away in ashes is absolutely lost. If this were unavoidable it could properly be called waste, but this is not altogether unavoidable and through proper methods may be saved to a large degree.

There are now available a great many fuel saving devices which should be considered by power plant operators, as the saving in fuel in a great majority of cases more than pays for their installation in a short time. Such devices as superheaters, feedwater heaters, stokers, feedwater regulators, fuel economizers, air and steam flow meters, water treating devices, etc., should receive careful attention, and a thorough study in order to determine their value.

Dr. Charles P. Steinmetz has also made the statement that he considers it hopeless to anticipate much improvement in the burning of coal and coke, and on an average we get barely more than 10 per cent of the value of the coal for power, the remainder going off as heat. The only solution is to use the carbonized fuel from the oven in such a way as to get out of it both the power and the heat. It is then a very important matter to give undivided attention to the conservation of the heat, and the biggest factor in this regard is proper insulation of exposed parts.

Another important phase is to make use of all exhaust steam (this represents heat) for heating buildings, drying materials, operating low pressure turbines, etc.

The power plant engineer who is wide awake is having his attention drawn very forcibly to the importance of strict conservation, as there have been endless circulars issued by the government, state and municipal authorities as well as numerous articles in the leading technical journals and with all this vast amount of literature emphasizing economy there is no excuse for undue waste. It is necessary, of course, to consider thoroughly conditions in the individual plant, for instance possible economies with superheat depend upon how far the plant has already been developed along lines of thrift. The only way to adequately judge the worth of superheating in any plant is to consider the economies made possible by its use, the first cost, maintenance cost and the simplicity of its installation. It has been claimed that it is possible to save as high as 15 per cent of fuel; in such cases the superheater would soon pay for its installation. This same application can be made to other appliances, and the merit of each should be studied and considered from all angles.

Efficiency versus Losses

The term "efficiency" when applied to a furnace means the combined efficiency of the boiler and furnace, this for the reason that losses are attributed to the complete apparatus.

The highest efficiencies that have been obtained with coal vary from about 82 per cent to 85 per cent. Loss of efficiency is therefore a direct waste of fuel, and failure to obtain full efficiency and capacity from a plant may result from:

Inleakage of air through boiler settings.
Improper methods of firing or draft control.
Insufficient draft.
Unsuitable fuel.
Unequal division of load between the several boilers.
Formation of scale and corrosion on heating surfaces.
Low temperatures of feed water.
Waste of exhaust steam.
Heat absorbed by boiler.
Improper or insufficient insulation.
Incomplete combustion of carbon.
Heat carried away in dry chimney gases.

The results of numerous tests indicate that a content of 10 per cent to 13 per cent CO_2 (carbon dioxide) should be obtained, and this would be considered good performance. Large excess of air is indicated by low CO_2 content and high-oxygen content, incomplete combustion being indicated by CO (carbon monoxide), which should be low in percentage. As a general rule the CO content in the flue gases should not be allowed to reach one-half of one per cent. Causes that may be assigned to excess of air, are: Holes in the fire, too large openings in the dampers of the firing door, badly warped fire doors preventing them from closing tightly, too frequent raking or slicing of the fire, leaky settings, fire doors being kept open too long.

It is quite possible to have the gases running as high as 14 per cent in CO_2 without a trace of CO, while in other cases a considerable amount of CO may obtain even with CO_2 running at 10 per cent. It should also be borne in mind that CO is only one of the combustible gases, and the actual loss from incomplete combustion may be twice as large as that indicated by the percentage of CO as there may be present H_2 (hydrogen) and in some instances a trace of CH_4 (methane).

Causes for Excess Air and Fuel Waste

One of the most common causes for excess air in flue gases is holes in the fire bed. This can be avoided through frequent firing and placing coal on the thin spots. It is highly important that the fireman understand combustion in order to get the maximum efficiency out of coal. He should keep in mind that it is his duty to make steam economically and not merely burn coal. He should not become discouraged if he finds it difficult to understand the principles of furnace efficiency, as there is no such thing as a royal road to knowledge, and it is quite necessary that the whole matter of combustion be carefully analyzed. Co-operation is also a big factor in the success of the plant and successful firemen and engineers do not overlook this very important matter.

To prevent waste of fuel it is necessary to see that all settings are tight in order to eliminate the infiltration of air. This is one of the largest single items of loss in the whole cycle of power production, and also one of the most common in its occurrence.

There are three important places to investigate for this air leakage:

1. Cracks in boiler walls and settings.
2. Leaks or air spaces between iron door frames and boiler walls.
3. Leaks around blow-off piping.

Cold air that leaks in absorbs heat until it reaches the temperature of the furnace gases, and hence wastes heat that would otherwise perform useful work. It is conservative to estimate on the following basis: if air leakage through boiler walls amounts to only 5 per cent of the actual quantity of air required for proper combustion and high efficiency, 1 per cent of the fuel burned is wasted. Leakage often amounts to more than 100 per cent and 100 per cent leakage causes fuel wastage of at least 20 per cent.

Cracks in the boiler walls may not be very apparent, yet may allow leakage enough to materially lower the efficiency of the boiler. Air leakage is easy to detect. A simple method is to take a sheet of paper about two feet square and cut out in the center a round hole about one inch in diameter. This sheet should be pasted on a square wooden frame made of four pieces of inch by inch stock. The frame should be held against the boiler wall with the paper side out, making the joints between frame and wall tight by using putty or fire clay. Then by holding a match or a candle in front of the hole, leakage through the four square feet of boiler-wall surface creates a draft through the one-inch hole in the paper. The amount of this draft is indicated by the sucking-in of the flame, and is usually quite surprising. To conduct this test successfully, it is essential that all joints between the frame and boiler wall be made air-tight.

Although air leakage is one of the most important causes of fuel waste, it is nevertheless one of the simplest to remedy. The application of a suitable insulation in sheet or block form and of proper thickness, finished with a smooth, tight surface not only prevents the infiltration of air but also reduces radiation or loss of heat from boiler walls. This remedy should always be used if boiler walls are hot and loss due to radiation correspondingly great.

Boiler walls may be made air-tight by applying to the outside of the wall a coating of material which will seal up cracks and which is itself sufficiently elastic to permit expansion and contraction without cracking. Wide or large cracks can easily be taken care of by caulking with material such as asbestos wick before the application of a coating as referred to above.

Open spaces around access and other door frames should be thoroughly sealed by means of a cement that will adhere to both iron and the brickwork and that will remain intact when subjected to heat and resulting expansion and contraction. Defective brickwork settings should be constantly repaired and the bricks should also be bonded together with a material which will not readily crumble or fuse away and which is capable of resisting heat and expansion strains. Additional protection to fire-brick settings may also be obtained by coating the interior surface with a refractory material.

Proper Amount of CO_2 (Carbon Dioxide)

A careful check should be made constantly in order to ascertain the percentage of CO_2 and particular care should be taken to see that this does not get too low. When it is found that the percentage of CO_2 runs below about 10 per cent it is time to study the conditions carefully and learn the cause, as it is certain that there is loss and waste of heat, which means loss in dollars and cents. It should also be understood that a definite percentage of CO_2 does not always indicate a certain efficiency, because it is quite possible to obtain a 10 per cent content of CO_2 with a certain efficiency while it is also possible with the same efficiency to show a 13 per cent content of CO_2.

The percentage of CO_2 indicates the volume of excess air flowing through the furnace and the boiler passes, or the ratio of the air that is taken in for the purpose of consuming the coal and that which is taken in and results in a wasteful cooling of the furnace gases. To burn one pound of coal requires about 14 lb. of air. This air enters the furnace at atmospheric temperature and leaves at a temperature of 500 deg. F. or more. During this transition it carries with it all the heat it has absorbed in being heated through this range of temperature. For each degree of temperature rise one pound of air absorbs approximately one-fourth of a heat

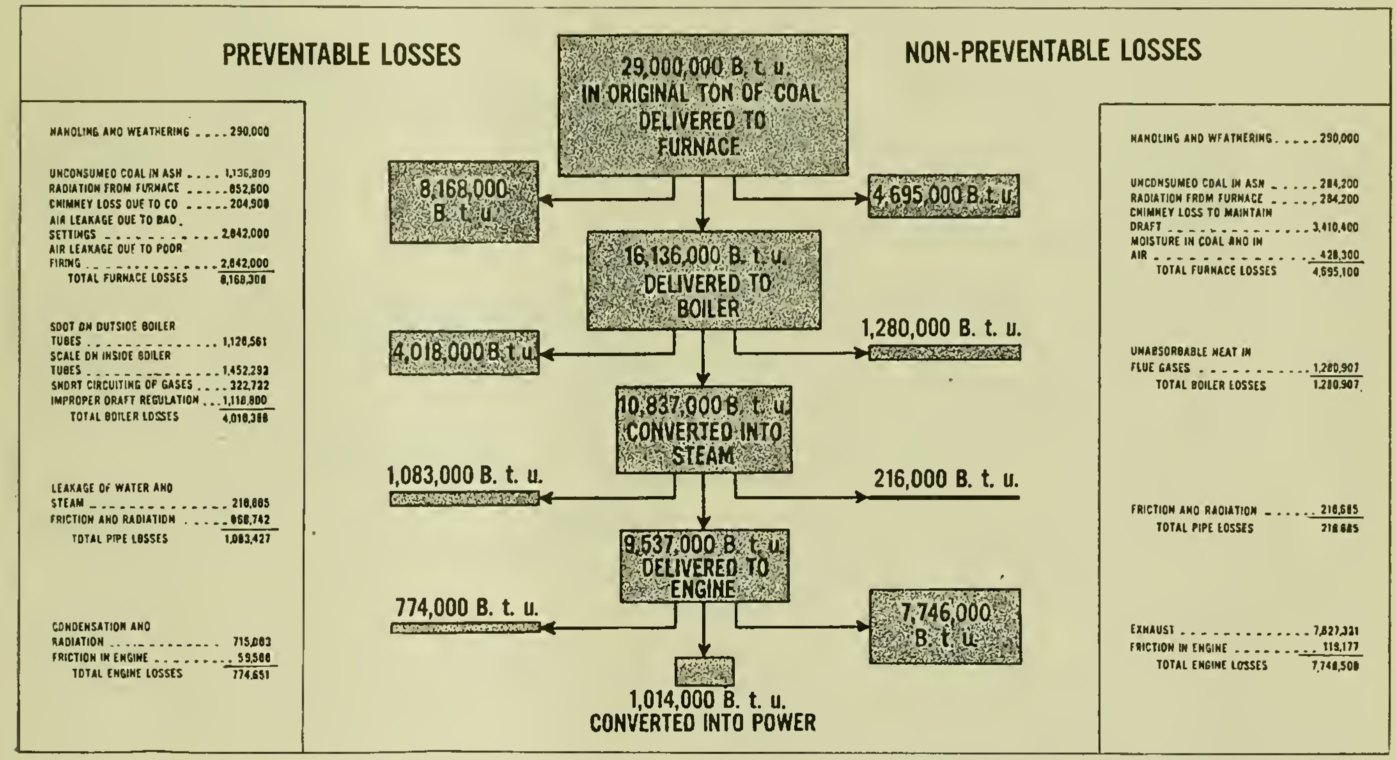

Fig. 1—Fuel and Heat Losses Between Mine and Crank Shaft

unit (B.t.u.), from which it is evident that each pound of air during the transition period on being heated to 500 deg. F., absorbs 125 heat units and therefore the 14 lb. of air required to burn each pound of coal absorbs 14 × 125, or 1,750 heat units. From this it is evident that all air in excess of this amount admitted to the furnace will carry away a large number of heat units, which is waste pure and simple. The waste then resolves itself into two factors, which include the amount of air entering the furnace and the temperature rise.

For determining the amount of CO_2 and CO the apparatus most frequently used is some form of the Orsat apparatus and no investment in power plant equipment will yield a larger rate of interest than a well used gas-analysis apparatus. Other equipment which is also indispensable includes the pyrometer and draft gage. By the use of the pyrometer the temperature of the excess volume can be determined, for in order to determine the preventable heat loss from excess air it is necessary to know the temperature as well as the volume. Draft regulation is one of the most important factors in combustion efficiency and the amount of draft should be such as to produce the best percentage of CO_2 without CO and still meet the load conditions.

These various appliances all have merit and conditions should be studied very carefully in the power plant with the view to their adoption as the initial cost is practically nil, considering the ultimate saving that can be realized by their installation. One of the greatest obstacles in the past has been the unwillingness of a large number of plant managers to spend a few dollars on the nonproducing part of their plants, but this is to a large degree being overcome, particularly during the past three or four years.

Fuel Waste and Where It Goes

The question is often asked, "How can coal be saved?" This is a question upon which much has been written during the past few years, and rightfully so, as the coal bill in all power plants has now become a vital factor and must necessarily receive the most searching kind of investigation.

When it is taken into consideration that a ton of good-grade coal delivered to the power plant contains approximately 29,000,000 B. t. u. and that the average plant delivers to the point of power only approximately 554,000 to 555,000 B. t. u. it is well nigh time to "sit up and take notice." As an illustration of where the losses occur in the average power plant the diagram in Fig. 1, taken from Joseph W. Hays' treatise on "How to Build Up Furnace Efficiency," will prove of interest.

It will be noted that by far the greatest waste is caused by the large amount of excess air that is permitted to enter the furnace and boiler setting and to escape up the chimney, which is carrying away heat that should otherwise be utilized to perform useful work. This unnecessary air is admitted in two ways, through uneven fires which leave part of the grates bare and through leaky boiler settings.

The loss due to uneven fires can properly be charged to improper operation and this is one of the important factors regarding which the fireman should be properly informed in order to correct it.

The loss due to leaky settings is even more important for the reason that it is not so easily detected. This forms an enormous preventable loss and the question of tight boiler settings is not debatable, therefore one of the first and important steps is to insure that the boiler settings are made tight with a suitable air-tight coating. This coating should be of a nature that it will expand and contract with the brickwork as well as being capable of withstanding the high temperatures, and retain its elasticity. Such a compound is on the market; it is cheap, easily applied and presents one of the best investments that can be made. Too much stress cannot therefore be brought to bear on this important matter of maintaining the settings in such a manner as to have them free from leaks. Fuel losses measured by CO_2 and flue temperatures are shown in Fig. 2.

Leaky Baffle Walls and Settings

Unless baffle walls are tight, part of the hot gases from the furnace will short-circuit or take a direct route from the fires to the stack, whereas with perfectly tight baffles the gases must follow the path prescribed for them and pass over the entire heating surface. Excessive leakage through the first baffle, or the one nearest the fire, can often be detected by looking through the dusting-doors or peepholes just beyond the baffle.

In constructing or repairing baffle walls, joints should be eliminated wherever possible, whether between sections of the baffle or around tubes. The more nearly air-tight the wall can be made, the higher will be the efficiency of the boiler; this is no doubt generally conceded to be a fact by all power plant men.

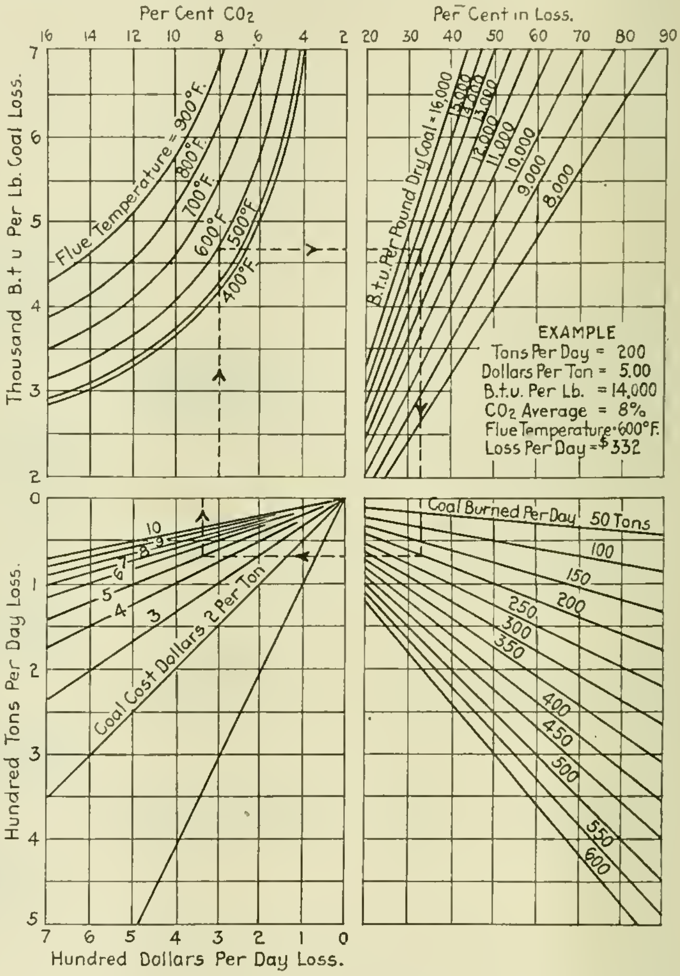

Fig. 2—Fuel Losses Measured by CO_2 and Flue Temperatures

Every substance expands and contracts under temperature changes. In each 180 deg. iron changes one part in 800 approximately, while firebrick changes one part in 2,000, which of course is a great variation. The result is that the iron-work expands more than the brickwork, and there is necessarily a slight relative movement between them as the expansion takes place. As the boiler cools the reverse condition occurs and this contraction and expansion soon develops cracks and openings so that the settings require close attention at all times. These leaks can be located by the method referred to heretofore or by throwing a scoop or two of green coal on the fire and closing the damper tightly. In this case the result is the reverse; the pressure inside the furnace is increased and smoke will soon be emitted through any opening or crack by which air would enter.

Another source of leakage commonly overlooked is in the division walls between boilers set in batteries. Leaks in these walls are just as bad as in outside walls, as the live boiler will draw cold air from the dead one and the ultimate results are the same

Efficiency of Combustion

It has been found that a proportion of about 11.5 lb. of air to every pound of carbon in the coal is necessary in order to insure complete combustion and furthermore this quantity of air must actually come in contact with the fuel. Incomplete combustion is due mainly to two causes, namely—insufficient air supply and failure of air to mix with the combustible rising from the fuel bed. Air is just as necessary for combustion as is the coal itself and for every pound of coal burned on the grate, 7 lb. of air must be admitted to flow through the bed of coal.

It is also very necessary that the bed be kept uniform and free from holes as the majority of air flowing through the holes does not aid in the combustion. On the other hand it absorbs a large amount of heat that is carried out and lost through the stack.

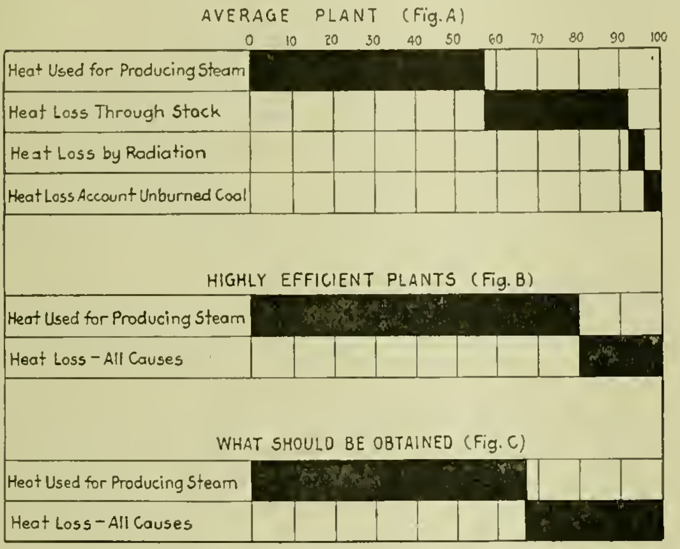

Fig. 3—Chart Showing Field for Saving in Heat Losses in Power Plants

The additional air needed to aid combustion should be admitted as close to the fuel bed as possible at a high velocity through small openings to bring the combustion up to the highest efficiency. Under no circumstances should this excess air be admitted through holes in the fire. As stated heretofore it requires approximately 14 lb. of air for burning one pound of coal, and in view of the fact that the swift passage of air causes some of it never to reach the fuel, air excess as high as approximately 40 per cent of the air conveying the oxygen required should be used, this depending upon the furnace construction. This matter of combustion could very easily be dwelt upon at length without covering the whole field and only the more important factors can be referred to in this article.

The construction of the furnace also regulates the quantity of excess air required for complete combustion and in some cases it may be as low as 12 per cent or 15 per cent, but it is not considered advisable to go below 20 per cent and may go as high as 40 per cent.

If the composition of the fuel is known, the percentage of excess air may be found approximately by the following formula No. 1:

$$\text{Percentage of excess air} = \frac{2100}{CO_2\ (1 + 3H)} - \frac{100 + 238H}{1 + 3H}$$

in which

CO_2 = Percentage of Carbon Dixoide in flue gases.

H = Weight of available hydrogen per pound of carbon in coal burned.

By the application of this formula when the percentage of CO_2 is known the important factor, excess air, can be ascertained. Efficient combustion results when the fuel is burned completely with the minimum amount of excess air and no further air is permitted to admix after combustion is completed. Complete combustion liberates all the heat contained in the fuel but efficient combustion requires that the heat be liberated in such a way as to give the maximum effect for producing steam; combustion efficiency can then be stated as shown by formula No. 2:

$$\text{Combustion efficiency} = \frac{\text{Heat available for making steam}}{\text{Heat contained in fuel burned}}$$

The heat carried away and lost up the chimney may be determined by formula No. 3. Although the results do not indicate all the heat wasted, yet it will be close enough for all practical purposes and shows the heat loss in B. t. u.'s per pound of carbon burned.

Formula No. 3

$$\text{Heat losses in flue gases} = \left(0.24 + \frac{58.46}{CO_2}\right) \times T$$

CO_2 = Percentage of Carbon Dioxide in flue gases

T = Difference between the temperature of the escaping gases and the temperature of air in boiler room in degrees "F."

It has been found in the average steam plant that the distribution of the heat in the coal is about as represented in Fig. 3. From figure A in this diagram it will be noted that for the average plant about 57 per cent of the heat is utilized for the actual production of steam, while about 43 per cent is lost. Figure B is representative of what is obtained by the best performances or about 80 per cent of heat utilized for producing steam and 20 per cent lost. Figure C shows what should be obtained and by increasing the percentage from 57 per cent to 67 per cent, which would mean a saving of about 15 tons of coal out of every 100 tons.

(*To be concluded in the March issue*)

If a belt slips after being cleaned and properly adjusted, it is probably overloaded, and the size of the pulleys should be increased.—*The Melting Pot.*

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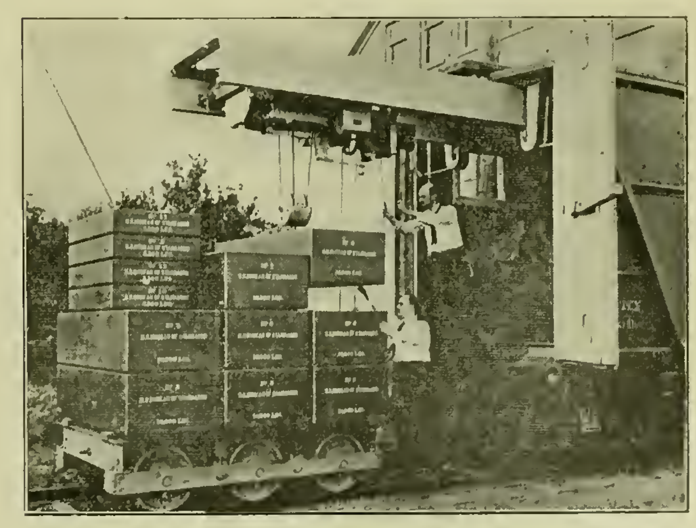


Photo by International

A Track Scale Testing Car of the Bureau of Standards

Labor Board Opens Hearings on Working Conditions

Carriers Oppose Perpetuation of National Agreements; Employees File Charges Against Roads

THAT the national agreements between the railroads and various classes of their employees, instituted within six months before the end of federal control, should not, in the interests of "honest, efficient and economical management" be continued longer under private operation, was contended by representatives of the railroads before the Railroad Labor Board on January 10 during the opening hearings on the demand of railway employees for the perpetuation of these agreements.

"The only parties who are fully qualified to consider such regulations are the individual managements and their employees," testified E. T. Whiter, chairman of the Conference Committee of Managers of the Association of Railway Executives, which is presenting the carriers' side of the controversy.

The reasons for the carriers' opposition to national agreements were outlined in the opening statement on behalf of the railroads. This opposition, according to Mr. Whiter's testimony, is based on the facts that:

(1) They are ultra-restrictive and therefore prevent the honest, efficient and economical management demanded by the transportation act;

(2) The variable conditions in different sections of the country make the universal application of their provisions impracticable;

(3) The existing rules, the continuation of which is proposed by the men, are capable of various constructions;

(4) The existing agreements provide that the rules contained therein shall apply to all employees of any particular craft regardless of the department of the railroad in which the man is employed; thus leading to a division of jurisdiction and a conflict in the working rules applicable to employees engaged in the same work;

(5) The existing agreements have destroyed acknowledged efficient and economical practices such as the piecework system for regulating rates of pay;

(6) The railroads must have relief from the rules controlling the employment of men, which are so restrictive as to prevent them from obtaining a sufficient number of employees in certain departments, thus interfering with output and causing delay to the movement of traffic;

(7) The agreements contain many rules which provide for payment of work not performed, and thereby cause many millions of dollars of unnecessary expense annually.

"The railroads do not object to schedules (the technical term for railway agreements) properly negotiated and entered into with their own employees," Mr. Whiter said, "as is evidenced by the fact that nearly all, if not all, of the roads represented by this committee, have had schedules with the various train service organizations for many years.

"Prior to federal control, some roads had schedules with other classes of their employees; many had no schedules with any crafts other than the train service organizations, but there were no so-called 'national agreements' which made all rules uniformly the same throughout the country. All roads that did have schedules directly negotiated them to fit their own conditions with their own men, and in every case the railroads had the undisputed right to negotiate their own schedules, which was denied during federal control.

"Under governmental control the railroads were unified, and the director general entered into so-called 'national agreements.' These agreements, which were of universal application for the period of federal control, were specifically recognized by the parties signatory thereto as effective during this period only."

During subsequent hearings Mr. Whiter presented testimony regarding the shop crafts agreement, showing how the rules operated to increase labor costs exorbitantly and decrease efficiency. As readers of the *Railway Mechanical Engineer* are familiar with this matter no attempt will be made to report the details of the testimony.

Mr. Whiter's testimony regarding this agreement was completed on January 18, following which representatives of several of the larger carriers presented detailed statistics to show that the abolition of the piece work system of pay in railroad shops has resulted in serious decreases in the efficiency of the individual worker and consequently in the output of the shops.

Unions Criticize Contracts for Repairs

At the opening of the hearings on January 10, B. M Jewell, representing the American Federation of Labor, presented a statement in which he attacked the contracts for repairs which the railroads have made with outside shops. W. Jett Lauck, representing the International Association of Machinists, filed a petition for an investigation of these contracts with the Interstate Commerce Commission, although the commission had already announced that such an investigation was already under way.

The petition charged that the big railroads, "especially those affiliated in a financial way with J. P. Morgan & Co., are closing their repair shops, throwing thousands of union men out of work and giving repair work at extortionate rates to large private equipment companies in which railroad capitalists or banking groups are heavily interested." It was also stated that more than 30,000 union men already have lost their jobs under this plan and a combination of figures was built up as the basis for a statement that the railroads are "milking the national treasury of three-quarters of a billion dollars and manipulating the funds in a campaign to drive the railroad unions out of business," and that in this fashion the railroad managements hoped "to send the unions on the rocks and charge the bill to the public through taxation to pay the subsidies guaranteed by the federal government or by maintaining present high rates."

Neither the press statement nor the petition explained that the car and locomotive repair work was sent to outside shops during the guaranty period during which, under the law, the railroads will be allowed to charge to maintenance expenses for the purpose of figuring the guaranty only an amount to be determined by the Interstate Commerce Commission, nor that most of the lay-offs of shop employees referred to occurred at a later period, after the volume of railroad traffic had been greatly reduced. The petition stated that locomotive repair work when done in the outside shops costs the railroads on an average four times as much as it costs in their own shops. The petition suggested the following policy for correcting the alleged evils:

"1. That no railroad company be permitted to enter into contracts for repair work on locomotives or cars by outside companies unless given a permit to do so by the commission, and

"2. That as a condition to securing such a permit, the railroad companies must show: (a) They cannot do the work which they wish to contract for, or (b) They cannot do it at as low a cost as they can have it done by outside companies, and (c) If a permit is granted, that the same rates of compensation and the same conditions of employment will be observed by the contractors as are recognized and guaranteed to railway workers by the Transportation Act of 1920, and the Awards of the Railway Wage Board established by this Act."

Later another statement was given to the press quoting Mr. Lauck as to the alleged actual records of contracts for repairing 617 locomotives and about 32,000 cars during the past several months. The following table was given as showing a comparison between railroad and private shop costs on the basis of the data secured by the unions and those ascertained by the Railroad Administration:

Cost of Locomotive Repair Work by Private Companies and Cost of Similar Work in Railroad Company Shops in August and September, 1920

Number of locomotives	Name of company doing work	Total cost	Average cost per locomotive
234	Baldwin Locomotive Works..........	$4,691,176	$20,048
27	Rome Locomotive Company............	459,000	17,000
41	American Locomotive Company.........	670,760	16,360
9	Lima Locomotive Works.............	149,535	16,615
11	Charleston Dry Dock Company.......	66,000	6,000
9	Southland Steamship Company.......	54,000	6,000
10	Merrill & Stevens	120,000	12,000
6	Broad Foot Iron Works.............	72,000	12,000
1	Pittsburgh Boiler & Mch. Co.........	1,670	1,670
2	Manufacturers Railway Shop.........	25,080	12,540
350	Total and weighted average......	$6,309,221	$18,026
1,080	Railroad Company Shops............	$5,504,144	$5,096

In this statement it was stated that the locomotive repair bill under the private contract system would be raised from $500,000,000 a year to $1,500,000,000 annually and the car repair bill from $400,000,000 to $800,000,000, a total increase of $1,400,000,000.

Practically all the data regarding the cost of repairs, as included in the statements of the machinists' union, were brought out in a speech by Congressman Huddleston of Alabama in a recent speech in the House of Representatives. In the report of the speech contained in the Congressional Record, a tabulation of contracts for repairs to locomotives and cars is shown with a further statement of the cost of classified repairs in certain railroad shops. The data regarding repair contracts show that the cost per locomotive ranges from $1,670 to $30,275.70. Practically no information is given as to the extent of the repairs. The work done in railroad shops is subdivided under the various classes of repairs, the cost being as follows:

Class 1..............................	$26.069.23	(one road only)	
Class 2..............................	8,195.64	to	$14.498.14
Class 3..............................	4.471.66	to	10,658.39
Class 4..............................	2,093 71	to	4,576.11
Class 5..............................	1,002.09	to	4,025.45

Railroads Reply to Charges of Labor Leaders

Following the publication of these charges many of the railroads gave out detailed statements defending the contracts for repair work. It was pointed out that in many cases the terms were the same as in contracts made by the Railroad Administration.

Thomas DeWitt Cuyler, chairman of the Association of Railway Executives, issued an official statement in which he denied the charges of labor leaders that railroads were paying excessive costs for equipment repairs as an attempt to deceive the public. At the conclusion of his statement Mr. Cuyler said:

"When the railroads were returned to private operation there was an abnormal percentage of cars and locomotives in bad order requiring repairs. The excess of bad order equipment was beyond the capacity of the railway shops, and the railway labor engaged in the repair of cars had declined in efficiency and output. These abnormal conditions required abnormal remedies to meet them. It was a matter of time and economy to utilize all the facilities of the equipment concerns of the country for these repairs.

"There is absolutely no truth in the charge that banks and railroad companies are in a 'conspiracy' against labor, the 'open shop,' or upon any other controverted point."

QUESTIONS AND ANSWERS

Location of Cylinder Center Above Center Line of Axles

Why is the center line of cylinders in most locomotives placed about 1½ or 2 in. above the center line of the axles?—H. C. Wilson.

The principal reason for placing the cylinder center line above the center line of the axles is to provide for wear in the driving box crown brasses and settling of the springs. If the cylinders and wheels are placed at the same level, the cylinder would be lower than the center line of the wheel after the engine had been in service or after the crown brasses had been bored. This would result in an undesirable condition as it would cause the thrust of the cross head to act downward at certain points in the stroke when running ahead. Normally, this pressure is against the upper guide.

Another advantage in locating the cylinder center above the center of the wheels is the fact that it raises the guides and reduces somewhat the amount of dirt that lodges on them. In some cases, it may also give increased clearance for the leading truck. Raising the center line of the cylinders above the center line of the axles increases the angularity of the main rods and shifts the dead centers so that they are not diametrically opposite. This introduces some errors in the valve gear but with the long main rods ordinarily employed, this is so small as to be negligible.

Finding the Speed of Trains

How can the speed of a train be found without timing it between mile posts?—J. B. Johnson.

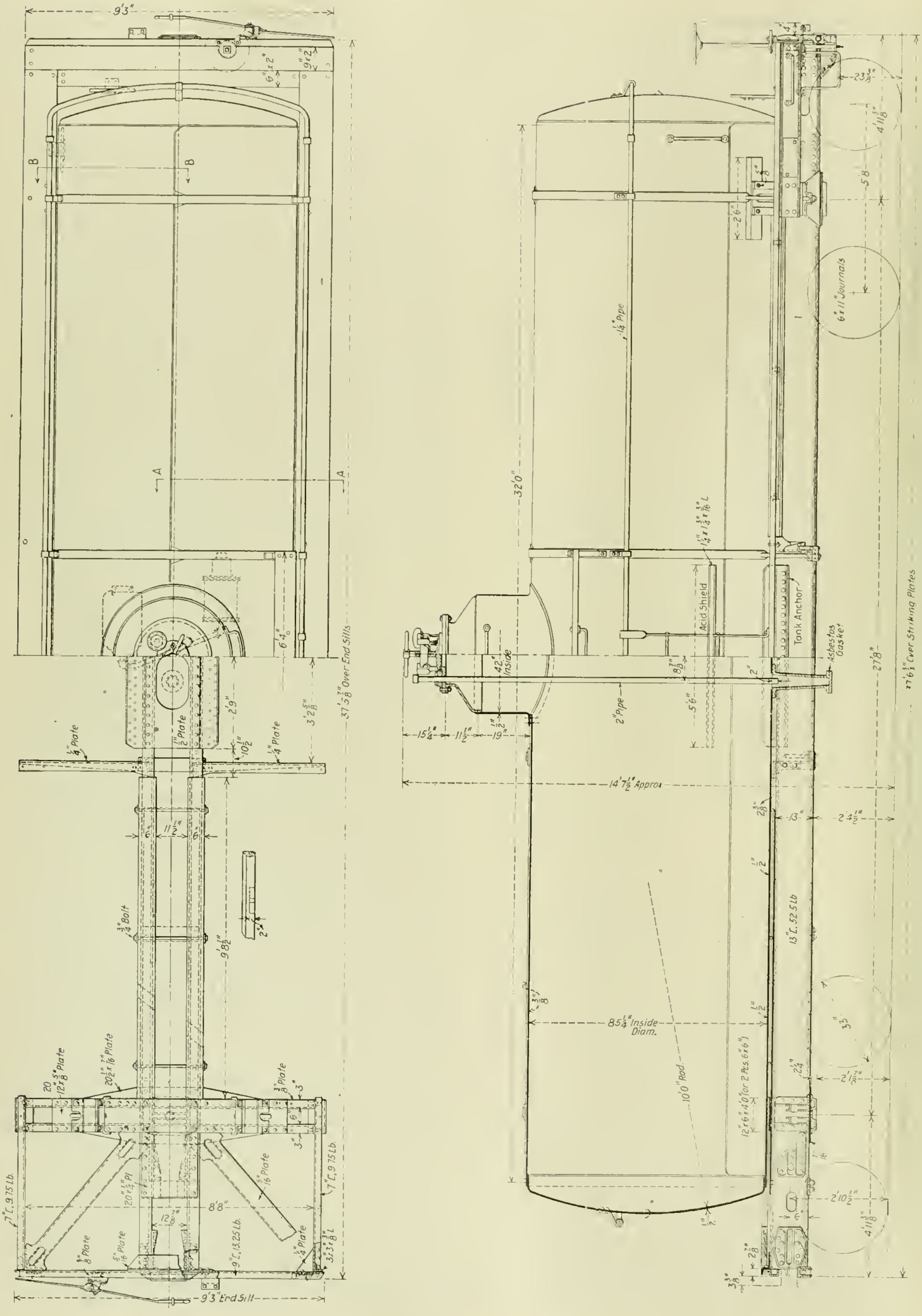
When running on double track, one of the easiest methods of finding the speed of a train is by counting the rail joints on the opposite track. Practically all rails are now made 33 ft. long, in which case the speed can be determined by counting the rail joints passed in 22½ sec. When riding in passenger cars, it is often possible to determine the speed by counting the clicks as the trucks pass over the joints.

In case the noise of the joints cannot be heard or if they cannot be seen, as for instance on single track, the speed can be found from the revolutions of the driving wheels. The time during which revolutions should be counted depends, of course, on the diameter of the drivers and can be determined as follows:

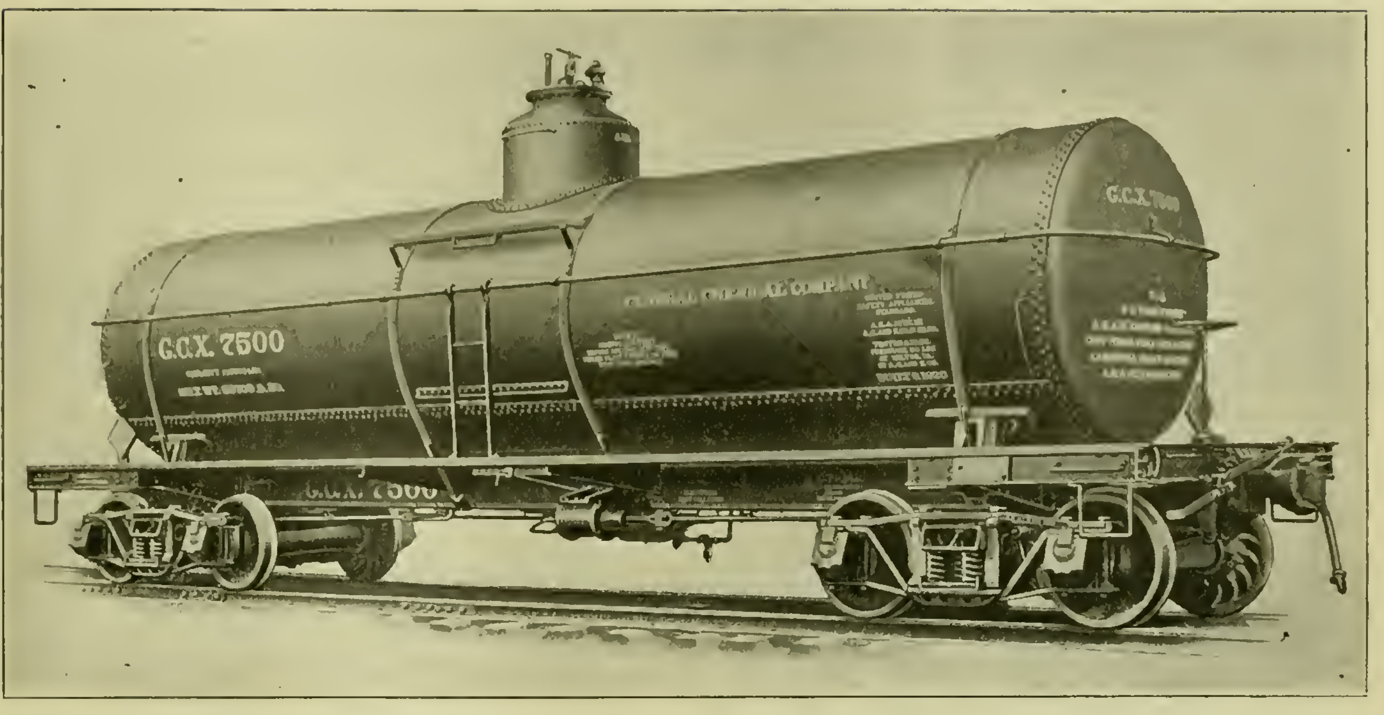
Find the number of revolutions per mile and divide this into 3,600 (the number of seconds in one hour). This will give the time in which the revolutions will equal the speed in miles per hour. For instance, if the drivers are 63 in. in diameter, their circumference is 16.46 ft. and they will make 312 revolutions per mile. The speed will be equal to the number of revolutions (3,600 divided by 312), or approximately 11½ sec.

Where trains made up of cars of uniform length are operated, the speed can be determined by counting the number of cars passing a given point, the time being found as above, substituting the length between couplers for the circumference of the drivers. Counting telegraph poles likewise affords approximate means of finding the speed.

Organized Railroad Labor, after a year of success in obtaining higher wages and promoting unity, faces the inevitable economic readjustments connected with post-war business reconstruction in 1921. The railroads face easier labor conditions, increased individual efficiency and a return to "an honest day's work for an honest day's pay" basis. Attitude and action of Railroad Labor Board will have a large influence upon a mutually satisfactory adjustment of the differences.—*Railway Age.*



Plan and Side Elevation of General Chemical Company 70-Ton Acid Tank Car

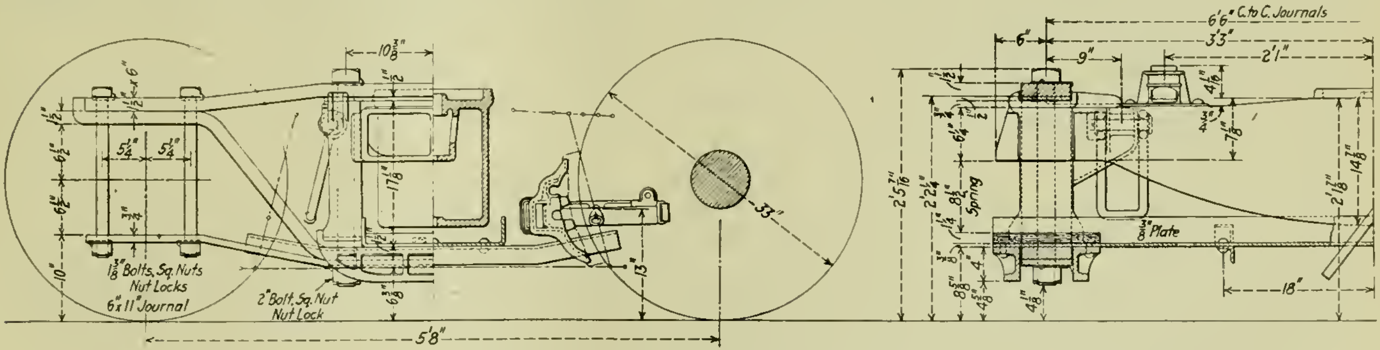


Sulphuric Acid Tank Cars of 70 Tons Capacity

Tank Made with Three Longitudinal Sheets Is Feature of Equipment Built for General Chemical Company

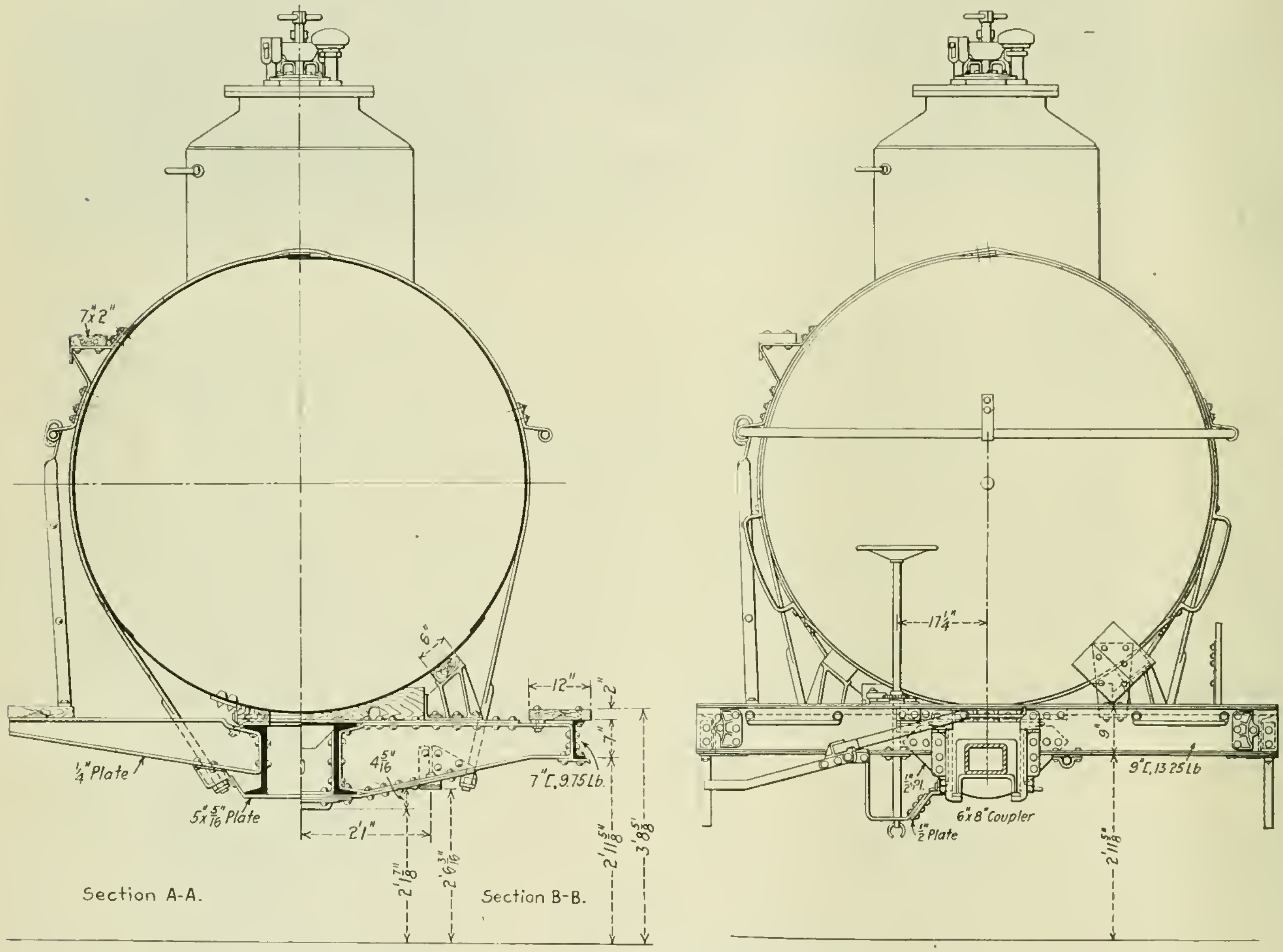
THE transportation of dangerous chemical products in large quantities has become so common that it receives but little attention from the railroads that move this traffic. To build equipment which permits handling such commodities in regular service without extraordinary precautions requires a high degree of skill in design and high-class workmanship. This is well exemplified in the recent order of 70-ton tank cars built by the American Car & Foundry Company for the General Chemical Company. These cars have a capacity of 9,800 gal. of sulphuric acid. The concentrated acid is nearly twice as heavy as water and if any considerable quantity of water comes in contact with the liquid, a violent explosion will occur. For this reason, the tanks must be strong, absolutely free from leaks and the dome must be tightly sealed.

With the exception of two cars built for the General Chemical Company in 1916, the 50 cars on this order are, so far as known, the first 70-ton acid tank cars constructed. The design was worked up jointly by the American Car & Foundry Company and the General Chemical Company, the owner's arrangement of dome fittings and outlets being applied. The tank conforms to the A. R. A. Class III tank specifications and is built to withstand a pressure of 300 lb. per square inch. The diameter inside the sheets is 85¼ in. and the length between the outer rows of rivets is 32 ft. The cylindrical section of the tank is made up of three longitudinal courses, each in one piece. The length of riveted seams is reduced considerably by this design. The bottom sheet is ½ in. thick, the upper sheets ⅜ in. thick and the heads ½ in. All rivets and seams are caulked on the inside and all seams are caulked on the outside as well. The dome has an inside diameter of 42 in. and is 30½ in. high with a cast steel dome head. The dome cover, which is also a steel casting, carries the usual safety vent with lead disc and a flange for the syphon discharge pipe. This pipe extends through the tank and into the outlet chamber,



Arch Bar Truck Used With 70-Ton Tank Car which is fitted with a blind flange at the lower end. The small filling cover is secured by a screw passing through the center of a removable yoke which fits into two toggle bars on the main dome cover.

The center member of the underframe is made of two 13 in., 52.5 lb. channels spaced 12⅞ in. apart. These extend continuously from end sill to end sill and are reinforced by a ¼-in. cover plate 20 in. wide. The bolsters are built up of pressed sections of ⅜-in. plate with top and bottom cover plates. The end construction comprises a 9 in., 13.25 lb. channel; short side sills of 7 in. 9.75 lb. channels; and diagonal braces of 5/16-in. plate. The running boards are supported by pressed steel cross bearers. A ½-in. anchor plate extends across the center of the underframe and the outer edges are bent down to conform with the outline of angle-shaped anchor plates riveted to the tank. The arrangement of the two parts of the anchor is such that the underframe is given a slight downward camber at the center and the tank is relieved of any stresses due to buffing shocks which otherwise would be transmitted to the sheets. The rivets which join the tank and the underframe are made readily accessible by this arrangement so that they can be riveted by machine and the tank can be removed for repairs without cutting any of the rivets in the tank itself. Practically all center anchorages on tank cars have been bolted to the underframes as outlined in the tank car specifications and a riveted anchor is a comparatively recent innovation. An acid shield on each side of the tank protects the anchorage and the air brake equipment in case acid is spilt from the dome while the tank is being filled or emptied. The ends of the tank rest on wood saddles held by bracket castings on each side of the bolster. An additional support is provided along the center sill by wedge-shaped wooden stringers which can be drawn together by transverse bolts.



End Elevation and Cross Section of General Chemical Tank Car

The trucks, which are of the arch bar type, have a base casting spanning the bottom of the bolster opening. This furnishes a means of attachment for the spring plank and also provides support for the lower end of the pedestal column. Many of the specialties applied to these cars were furnished by the General Chemical Company, including the safety vent, outlet castings, dome heads and fittings and all tank gaskets. Other equipment includes Cardwell G-11-A draft gear, Westinghouse type KD-1012 brake equipment, National journal boxes with coil spring lids, Huntoon brake beams and Stucki side bearings. The average light weight of the cars is 50,400 lb.

To Clean a Lead Spot, it is advisable to add dry, common salt, and stir thoroughly with the molten lead. All dirt and foreign matter will rise to the surface, and can be skimmed off with ease. —From Houghton's "Steel and Its Treatment."

Steam-proof Belt Cement.—Many engineers are of the opinion that lacing must be used on belts exposed to steam, as belt cement will not hold under such conditions. While this is true of some kinds of cement, steam will not dissolve a belt cement made on a pyroxylin base because it is waterproof and not affected by moisture.

Cause of the Present Condition of Freight Cars*

Pooling, Deferred Retirements, Labor Conditions and Abuse in Service; the Remedies Suggested

BY J. C. FRITTS

Master Car Builder, Delaware, Lackawanna & Western, Scranton, Pa.

WHEN a bad condition is found an effort should first be made to find the cause and then work out some method by which the evil can be combated. So much has been said in regard to tightening nuts, opening cotter keys, measuring piston travel, etc., that I thought we might pass that part of car maintenance tonight, assuming that it was being well taken care of, and go a little deeper, with a view of suggesting something constructive.

In order to properly analyze the present unsatisfactory condition of freight cars, it will be necessary to go back two or three years and ascertain what has occurred during that period that would contribute to the present situation. If this can be determined with any degree of accuracy, then we should be able to suggest something that will give us relief.

Effect of Pooled Equipment

Formerly it was common practice to maintain the majority of cars on home lines, but during the war the pooling of freight cars was deemed necessary, and cars on home rails in many instances were reduced to ten per cent of the equipment owned. It does not seem at present that we are going to get back to previous conditions in this respect for some time to come, if ever. The result has been, and still is, that a very large percentage of cars in bad order are of foreign ownership, for which the handling line does not carry in stock standard material, except a few M. C. B. parts. Therefore, in lieu of repairing in kind, improper and temporary repairs have been made in order to return the cars to service.

All railroads throughout the country have been repairing cars in this manner. It was the best they could do under existing conditions. Such methods are responsible in a very great measure for the condition of freight car equipment at this time.

A check and inspection of system cars received home at interchange points developed that a very large percentage were in need of extensive repairs and a large number had defects that could have been repaired by using standard material. This would seem to indicate that returning equipment to owners only when it has become unserviceable is being practiced to a very great extent.

Imagine what is going to happen with 75 per cent or more of all cars in the country on other than owning lines with conditions of this kind existing. I do not mean to say that there has been willful neglect on the part of railroads in general, but an analysis of the situation shows that these things have been forced upon them by the scarcity and mixing or pooling of equipment.

Repairs to cars have been retarded:

First, because the car department forces have not been familiar with the class of cars they have been required to repair and necessarily have consumed more time than was customary on home line equipment.

Second, it was formerly customary to manufacture parts for system cars in large numbers which were placed in stock and could be used as needed. They were made with standard patterns, formers, dies and other labor saving devices, at the minimum of time and expense, but with foreign cars in the majority on shop tracks this practice could not be continued, as there was not a sufficient number of system cars received to warrant the manufacture of various parts in any great amount. Practically all such parts for cars of foreign ownership require special operations through the manufacturing section of our shops, thereby losing the benefits of the labor saving devices that were previously in use. This has resulted not only in reducing the shop output, but has greatly increased the cost of production.

Old Cars the "Weakest Link"

Train tonnage is being increased from day to day; heavier locomotives are built with greater drawbar pull, and two or more are coupled together on heavy grades, or where it may be necessary to maintain fixed tonnage; heavy rails with rock ballast have been laid; new and stronger bridges have been constructed and all modern appliances for transportation have been adopted. The freight car from 15 to 20 years old is expected to take its place in this line of modern improvements and successfully perform service that is two or three times greater than was originally intended when the car was built. It is unreasonable to expect the old freight car to function efficiently against such odds.

If we were handling the same train tonnage with the same locomotives that were used when the cars that are failing were built less trouble would be experienced. The sooner railroads strengthen the weakest link in transportation, which is the car, the quicker results will be obtained. Many of these cars are of old and weak construction and their failure not only results in damage to themselves, but frequently causes serious damage to other good cars that are being handled with them. The majority of these cars are repaired in kind instead of being dismantled, as was formerly the practice.

Cars with short draft timbers, extending from end sills to body transom, of which there are many thousands in service, cannot be handled with any degree of success with present transportation methods. Cars of this construction that have had new sills and ends applied and generally repaired, in many instances have them torn out and destroyed within a few miles of the shop where repairs were made. A number of railroads, however, have started to apply reinforcements, some of which are of substantial construction, while others are little improvement, if any, over repairing in kind, and seem to have been contrived to reduce the expense of application rather than to give service. The results of such a practice is, that the expense of upkeep, not considering service, will soon equal the cost of proper reinforcements and the weak cars will still be on your hands. This is false economy, and it would seem that the design of reinforcements for freight equipment is not being given the thought its importance deserves.

If this is true, and we all know it is, then surely something should be done to eliminate or prevent repairs of this character.

Effect of Labor Conditions

The labor situation has also contributed very largely to present conditions. Many of the old employees have worked faithfully and endeavored to produce an honest day's work, but as a whole they have not manifested the same interest or given the same loyal support as was formerly their practice.

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*Presented before the Western Railway Club, Chicago, January 17, 1921.

There seems to have been a spirit of getting by with the least possible amount of work and indifference as to the quality as well.

The leveling of rates for all mechanics in the carmen's craft has reduced shop output instead of increasing the production, as was expected by some of the advocates of this system. All men are not of the same ability, and the highly skilled mechanic feels that he should not produce more than one of lesser skill because he is receiving the same rate of pay. This is human nature, and we cannot expect a change in these principles until a different method of compensation has been inaugurated.

Railroad shops are among the very few manufacturing plants throughout the country where all mechanics are placed in one class regardless of skill, and where the thrifty and industrious employee is supposed to produce a sufficient amount of work without extra compensation as compared with the man with a shiftless and lazy nature. Such a system is wrong, as it not only works an injustice and hardship upon the employee, but the employer as well. The right of every man to earn in accordance with his skill and ambition to produce, should not be denied him. It is one of the fundamentals upon which the Constitution of our country is based.

Rules and regulations that required years to work out and establish for the other crafts, were put into operation at once in car department forces, with the result that there was a lot of confusion which finally was adjusted with not enough men in the country with the experience required by the rules, to cover the work then on hand. There was no method of creating more until three years had elapsed, and then only through the helper apprentice system. The duties of carmen are so varied and cover so many distinct lines of work that rules which govern blacksmiths, machinists and some of the other crafts cannot be applied to carmen in so short a period and meet all of the various conditions of car work.

The rules insofar as they refer to supplying carmen are not workable because they have closed the door on increasing the number of men that can be employed at this work. On account of the centralizing of authority, the former close personal contact between the employee and those in charge has ceased to exist; supervisors are not free to settle questions that may come up from time to time, but must be governed by decisions handed down by men who are many hundred miles away and who perhaps never have been on the grounds and certainly are not familiar with local conditions. Ability cannot be considered and is not a factor in promotion at this time. Seniority governs in all cases, at least to the extent of a trial, with the result that there are entirely too many trials and very little production in the meantime. All of these things and perhaps many others that could be mentioned have all had a tendency toward a general lowering of the employees' morale.

The effect of such a condition is reflected in the present condition of freight car equipment. These restrictions have affected shop operations to such an extent that it has been found impossible to maintain bad order cars within a reasonable percentage.

The Misuse of Equipment

We hear much in regard to speeding up and increasing efficiency in operation; that more cars must be loaded and carry a greater tonnage; that the miles per car per day should be increased. But those in charge seem to have lost sight of the fact that a great factor in bringing about these results is keeping the greatest possible number of cars in service, and that this in a great measure depends upon the manner in which they are handled. Very little, if any, attention or consideration is given to the misuse of equipment. The only thought seems to be of delivery and loading or unloading, and if damaging or mutilating the car would in any way assist in this operation, there is no hesitancy in doing so. It is not uncommon, however, to receive complaints about the large number of cars it becomes necessary to bad order after receiving usage of this nature.

These destructive methods have been gradually on the increase for the last two or three years, and have not been confined to hump and classification yards. At piers and wharves, and in fact, at all loading and unloading points, the abuse of cars is always in evidence. It has become almost impossible to maintain cross ties, brake staffs and wheels, where clamshell unloaders are in use, notwithstanding the fact that these must all be replaced before the car can be returned to service.

Roofs, doors, door tracks and fixtures, flooring, lining, and in fact any part of the car that might affect the unloading operation, are torn off and destroyed, apparently without the least thought of the important position the freight car holds in relation to moving the country's traffic.

Many thousands of cars are thus damaged and sent to shop tracks daily, which otherwise could be loaded again without repairs, not only reducing the cars out of service on account of bad order but greatly assisting in increasing car mileage and the number of cars loaded.

While the material situation has improved during the last two or three months, it has contributed its share in full measure to the difficulties that have been experienced in properly maintaining cars in serviceable condition. Manufacturers have received orders in excess of their capacity to produce, and when finished, the scarcity of cars very often prevented prompt shipment of the material. This and embargoes placed on company material from time to time made proper and prompt repairs impossible even though other facilities were adequate.

With all of these conditions existing, is it any wonder that we find freight cars run down and worn out, and need those in charge of car maintenance feel that they have fallen short in the performance of their duties? I believe you will all agree with me in stating that they have done well, all things considered.

The following suggestions will assist in relieving the present unsatisfactory condition of freight cars throughout the country.

When possible from a traffic standpoint, cars should be returned to owning lines where repairs can be made. The old and light constructed cars could then be dismantled or assigned to special home line service and those that warrant being continued in service should receive substantial reinforcements that would be in keeping with the service they are required to perform.

All railroads are under moral obligations to do this, because they expect such cars to be accepted and handled in through line traffic by other railroads. Under the present system of pooling equipment through Commission orders, etc., a railroad that builds and reinforces in line with good practice will receive very little benefit from so doing, unless all other roads do likewise, because the exchange of cars between railroads has increased to an extent that 75 per cent of equipment on line is of foreign ownership and cars that receive extensive repairs today will probably leave the home line tomorrow and not return for several years. Therefore, there should be some agency established between railroads that will prevent the application of reinforcements or the perpetuating and offering of cars in interchange traffic that are unfit from a strength standpoint for general service.

All railroads have had sufficient experience to indicate to them that cars with short draft arms extending from end sill to body bolster cannot be handled with any degree of success, especially on trunk lines in heavy tonnage trains, and after a reasonable length of time has been given, they should be refused in interchange regardless of type or capacity. A very large percentage of the present bad order equipment can be confined to approximately 400,000 cars in the United States.

All that the majority of these cars need to make them serviceable for many years to come is the application of proper reinforcements.

If the pooling of cars is to continue and it becomes impossible to return them to home rails, then so far as it may be practical, certain common standards applicable to the most of this equipment should be adopted. These should be applied regardless of where the cars may be. This would not only hasten placing them in proper, serviceable condition, but would very materially assist in their future maintenance.

The General Committee of the Mechanical Division of the A. R. A. should appoint a committee for this purpose, and work out a system that would enable all railroads to reinforce such cars when placed on shop tracks for extensive repairs, regardless of ownership.

The condition of many cars received home shows that repairs for which standard material could have been used have not been made, indicating that cars of foreign ownership are not receiving the attention that present conditions would warrant or permit.

Under the present arrangement a railroad should, so far as possible, give the same consideration to foreign cars that it does to its own cars, and the failure to do so will react against the proper maintenance of freight equipment as a whole.

It has been stated that the writer is in favor of no labor unions and low wages, and that in saying so, he has voiced the sentiments of the "higher-ups." Nothing could be further from the facts. I believe in labor organizations that are conducted on just and moral principles, and that every man is entitled to fair and just treatment and his day in court. No superior of mine has ever suggested or even intimated to me what my views should be on this subject. Employees are entitled to safe and sanitary working conditions and regardless of the class of work a man performs, if he is willing to produce an honest day's work, he is entitled to a good living wage—by that I mean, enough for himself and family to live comfortably, to educate his children, and without extravagance, to lay away something besides. And treating this as a basis, every man should be paid according to his ability and willingness to produce. It is the only fair and just method of compensation, and a system that would make this possible should be inaugurated.

Rules that have been found to be unworkable and those that have inflicted unjust and unreasonable penalties on employers should be replaced with others that will equitably and fairly meet the conditions they are intended to cover. Men who are thoroughly familiar with their class of work should be placed in charge. They should understand human nature and the difficulties under which employees must at many times perform their work; men that will keep in close personal contact with those under their charge and who are quick to see and correct a wrong, regardless of where it may exist. No man feels satisfied to perform his duties from day to day without some recognition from his superior outside of the salary he may receive. Every faithful employee is entitled to this consideration. It not only creates a relationship of good will and loyalty, but inspires the employee to do better and more efficient work.

Supervisory officers of this type with proper authority ought to be able to meet and settle questions that may arise from time to time without the necessity of referring them to higher authority. If this is done, we should get back the morale and co-operation of our employees, which is very necessary in order to build up our production to a normal output.

So many cars are being damaged through carelessness, in many instances bordering on malice, that something should be done to prevent the destruction of company property by the misuse of equipment. I am somewhat at a loss for a proper and effective solution of this problem, but some sort of a campaign is necessary, because in many instances, those in charge appear to give this very important question no more thought than the employees they supervise. Much money could be saved if it could be instilled in the minds of those handling them, including some transportation officers as well as dock foremen and yardmasters, that cars are constructed, not to be damaged and mutilated, but to perform a very important service in connection with the life of our nation.

In view of the fact that a very large percentage of the damage to freight cars is caused by shock, draft gear maintenance is worthy of serious consideration at this time. The question of type or style of gear must be left open for further tests and investigation, but I believe that we should get the best out of whatever type we have in service. They perform more work and receive harder usage than any other device on a car, and it is the only one for the inspection and maintenance of which there are no specific rules laid down.

The function of a draft gear is primarily to keep down the pressure in the car underframe when under impact, which is done by increasing the length of time the forces are distributed through the car during such impact, in other words, by draft gear travel. It should always be remembered that none of the forces resulting from impact or collision are destroyed, but all remain in the car underframe to be disposed of or dissipated in one way or the other. Any wear or broken part that causes slack, reducing the effective travel of the gear, hastens the closing point, after which the pressure in car sills or underframe increases very rapidly.

If the function of the draft gear is as important as I believe we will all admit, then surely some systematic method of inspection and repairs should be installed on all railroads. We find that this is necessary in the maintenance of air brakes, wheels, and couplers. The cost to make such inspection or adjustments would not necessarily be greater than the expense of cleaning and repairing the air brakes, which the law compels railroads to do at least once a year, and I feel sure that the saving would be many times greater than the cost.

A periodical inspection should be arranged for and the dates should be stenciled on the car in a manner similar to the present practice with respect to air brakes.

Discussion

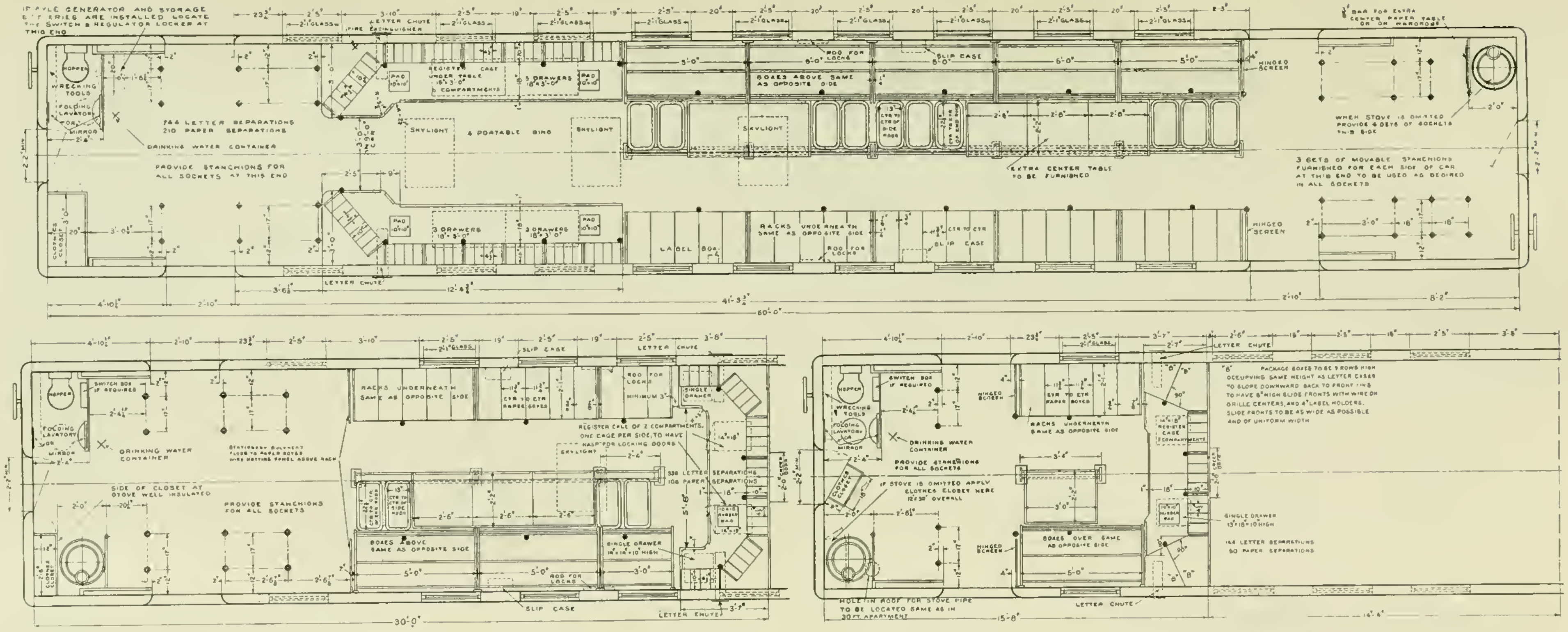
The paper drew forth a discussion on a wide range of subjects pertaining to the maintenance of freight cars. Several speakers referred to the frequency with which draft gears and attachments and box car ends were damaged and the suggestion of the writer of the paper that standard repairs generally applicable to all old equipment be developed by the Mechanical Division of the American Railway Association was favorably received, particularly as to standard car ends and draft reenforcements.

Several speakers called attention to the extent to which old cars with wood draft arms extending only as far back as the body bolster are receiving extensive repairs, as much as $1,200 being expended on heavy repairs to such cars, which are liable to fail immediately on being placed in service. Although the retirement of such cars was advocated several times during the discussion, it is evident that Rule 120 of the interchange rules has not accomplished its purpose.

C. N. Swanson (Atchison, Topeka & Santa Fe) strongly advocated fixing the A. R. A. prices for labor and material so high that owners would be forced to take proper care of their own equipment and that when cars are repaired on foreign lines the repairing road would be able to do the work at a profit.

C. J. Wymer (C. & E. I.) also advocated the policy of setting A. R. A. prices high enough to include a profit. In

(*Continued on page* 101)



Plans for Interchangeable 60-Ft. Full Railway Post Office Car and 30-Ft. and 15-Ft. Apartment Cars, (R. M. S. Drawing, Sheet O.)

(1) 60-FT. FULL R. P. O. CAR

This floor plan shows size and location of doors and windows so as to permit car body being used as a 60-ft. full car, a 30-ft. or 15-ft. mail apartment. When used as a 60-ft. full car, the windows shown in full lines and the three skylights shown by dotted lines are required. The windows shown in dotted lines can be installed complete in original construction, or provision made in framing for completion as required.

To facilitate widening of side doors, so that the entire car, or part of car, may be used in other than distributing mail car service, extra posts may be provided in side walls, of such nature as will permit widening the doors at minimum cost.

(2) 30-FT. APARTMENT

This plan locates doors and windows so as to permit the apartment being reduced to 15 ft. without change in this respect. If car is fitted up as a 30-ft. apartment when originally constructed the windows shown in full lines and the skylight in dotted lines are required. The windows shown in dotted lines can be installed complete or provision made in framing, for completion when change to 15-ft. apartment is made.

If it is contemplated that car may be changed at any time into a 60-ft. full car, the additional doors, windows and skylights shown on the 60-ft. plan can be installed complete, or provision made for these in framing, to be completed as required.

(3) 15-FT. (15 FT. 8 IN.) APARTMENT

The use of this plan, in lieu of the standard plan shown on R. M. S. Sheet F revised February 2, 1920, is optional. This plan is designed to permit the apartment being extended to 30 or 60 ft. without change in size or location of doors or windows. This involves the use of side doors of same width as those in 30 and 60-ft. mail cars, and the same space for toilet as in the larger units. These differences make the apartment 8 in. longer than the 15 ft. 0 in. shown on Sheet F, although there is no increase in the facilities in the apartment. Apartments built on this plan will be rated the same as the 15-ft. apartment shown on Sheet F.

(4) If length of car, inside measurement, exceeds 60 ft., the excess over 60 ft. should be added between side door opening and end of car. If this excess is greater than 3 ft., stove should be located at same end of car, on opposite side, and adjacent to door opening, with bulk-head of insulated metal plates to height of stove and wire netting panel above. Face of bulkhead to be flush with edge of door opening.

(5) *Skylights*:—Total exposed glass area of each, 5 sq. ft.; 60 ft. full car, three should be provided; 30-ft. apartment, one should be provided as shown. Where it is contemplated changing apartment to 60-ft. full car, the other two skylights may be installed complete or provision made in framing only; to be used as required; 15-ft. apartment, none required. Where it is contemplated changing apartment to 60-ft. full car the three skylights may be installed complete or provision made in framing to be used as required. Where it is contemplated changing a 15-ft. apartment to 30-ft. skylight called for in 30-ft. plan, may be installed complete or provision made in framing only to be used as required.

(6) *Bulkhead Radiators, Wall Coils*:—If used in 60-ft. car, locate bulkhead radiator on stove side, and wall coil on opposite side, at this end of car. At hopper end locate bulkhead radiator in stall adjoining clothes-closet. In 30-ft. apartment, locate bulkhead radiator in stall adjoining hopper, when stove is used. When stove is omitted locate radiator on wardrobe side. In 15-ft. apartment, locate bulkhead radiator in stall adjoining stove.

Bulkhead radiators should be located so that wire guard will be flush with door opening. Bulkhead radiator may be considered as equivalent to one set of movable stanchions. Wire mesh only, of ½ in. mesh heavy gage, to be used as heat pipe guard.

(7) Electric lighting shall be designed to furnish specified illumination on distributing facilities as shown on plans and on additional facilities required, when a 60-ft. full R. P. O. car is changed into an apartment car, the generator box should be moved into the baggage or passenger apartment of the car. Provision for making such change at minimum cost may be made in original construction.

(8) *Drinking Water Container, Drains*:—Drain pipes should be curved immediately under the container to side of bulkhead, or preferably, should empty into lavatory drain pipe, to insure minimum interference with piling of mail.

(9) Stove, if required, to have coal box under bulkhead insulated to top of stove, with wire netting panel above.

(10) Side door pockets to be solid, with opening along face 1½ in. to 2 in. high for removal of dirt from track.

(11) Brake wheel chain not to be applied inside of car.

(12) *Catcher Arm Brackets*:—Brackets for catcher arms and cinder guards to be applied at all side doors. Center of core of catcher arm brackets to be not less than 3 ft. 9 in. from floor of car.

(13) *Ventilators*:—Arrange layout as far as practicable so that correct number and kind (exhaust and intake, or combination) of ventilators will be in the various sizes of mail rooms.

(14) Hoppers, both flushing and dry, shall have double lids.

(15) *Overhead water tanks*:—Capacity must meet specifications for any size of mail room that may be provided in car body.

(16) Wall, deck and floor attachments securing distributing facilities (letter cases, letter case tables, racks and boxes for papers) shall be of such design as will permit of ready removal of facilities without defacement of car body, and permit substitution of sections of letter case and table for sections of racks and boxes for papers and vice versa. Attachments for securing letter case and table to be used as far as practicable for securing racks and boxes for papers, and same design of attachments to be used on all cars of any one railroad system.

Frame to be furred to support lighting and heating fixtures, letter cases, racks, rack latch dog (to engage rod No. 2 of the rack), boxes for papers, stanchion sockets, etc., as applied in car originally or when size of mail room may be changed.

(17) Hooks to be applied on side walls, over racks or in storage stalls, for hanging bridges.

(18) Paper boxes to have their own back which shall not answer for headlining.

(19) Indicates candle lamp brackets.

(20) For complete details of construction, refer to specifications revised February 2, 1920.

Note:—If railroad companies do not desire to use convertible features in 30-ft. and 60-ft. plans, windows shown in dotted lines may be disregarded. This refers to construction of car body only. See Note 3 regarding use of Sheet F for 15-ft. apartment.

Railroad companies contemplating the ordering of new mail car equipment will notify the department of their decision on these points.

this connection Mr. Wymer also advocated making all defects owners' defects and balancing this with a rental charge high enough to reimburse the owner for the upkeep of the equipment.

The effect of the present condition of freight cars on operating costs was touched on by D. I. Bergin (Wabash), who stated that hot boxes and bad orders created enroute were prolific causes of excessive fuel consumption and crew overtime. He called attention to the fact that all a railroad has to offer in competition is the service it can render; weak equipment which causes delays in the movement of traffic seriously affects the quality of this service.

In closing, Mr. Fritts called attention to the 40-ton cars with short draft timbers, many of which are in service, as needing equally as much attention as the 30-ton cars frequently referred to in the discussion. These cars, from the very fact that they are permitted to carry heavier loads may be even a greater menace than the similar cars of lighter capacity.

New Plans and Specifications for Postal Cars and Fixtures

The United States Post Office Department, Division of Railway Mail Service, has recently issued new plans and specifications for the construction of steel full and apartment cars and drawings and specifications for fixtures for mail cars.

The outstanding differences in the floor plans are the convertible feature of changing a 15-ft. distributing unit into a 30-ft. unit, or a 30-ft. unit into a 60-ft. unit, or vice versa. In order to permit of these changes, a common arrangement of door and window openings has been adopted. The new plans, which are similar to the optional layout issued in 1917, are shown on the opposite page. The distributing facilities have been rearranged, especially in the full railway post office car, so that the paper racks are kept together in line. A different letter case has been adopted and the distributing facilities built in units and made detachable so as to secure easy rearrangement.

In all three sizes, the letter case boxes are now 10 in. deep. On account of the large proportion of correspondence passing through the mails being enclosed in long envelopes, it was necessary to discard the short letter boxes which were shown in former plans and which were 7½ in deep. This facilitates the distribution by the clerks and tends to eliminate errors which might occur due to the long letters, when placed in the short letter boxes, obscuring the labels designating the boxes.

Comparatively few changes have been made in the specifications for the construction of postal cars. A new paragraph has been added to cover the design of self-propelled cars where the weight of the operating unit does not exceed 200,000 lb. The specification for skylights, which formerly called for ¼ in. rough wired glass or ⅜ in. rough plain glass, now specifies ½ in. rough wired glass or rough plain glass of equal strength. A few minor changes have been made in the requirements for lighting. If Mazda Type C lamps are used, they must have frosted or enameled bowls. Lights at letter cases are required to be located high enough so that the shadow of the reflector is not cast on any of the label holders. For emergency lighting, candles melting at relatively high temperatures, 120 deg. or more, must be used such as the Argand-Stearine or equivalent. The earlier specifications provided that if globes or reflectors of certain types were used, the service illumination values might be reduced 20 per cent from the minimum values otherwise required. Aluminum reflectors have now been added to this list. In the construction of protection guards for heating pipes, the use of wire netting or perforated metal was formerly optional with the railroad but the present specifications call for wire netting only. A note has been added stating that steel vestibule diaphragms are preferred. The rule for the location of brake and signal equipment provides that where apartment cars have but one signal valve, this shall not be located in the mail apartment. A few minor changes have been made in the list of interior equipment.

In the section pertaining to trucks, the detailed requirements in regard to brake shoe pressure and maximum weight per journal have been eliminated. A new sheet has been issued showing the approved standard lettering for the outside of mail cars.

Specifications for Fixtures

The principal change in the specifications for fixtures is the requirement that letter cases, tables, racks and boxes for papers shall be made up in standard sections and shall be secured to the car body by attachments of such design as will permit of ready removal of these fixtures without defacement to the car body and will permit substitution of sections of letter case and table for sections of racks and boxes or vice versa.

As noted above the letter cases have been changed and all boxes are now required to be 9¼ in. deep. The use of wood is not permitted in backs or perforated bottoms. Where partitions are made of wood, the material must be three-ply, thoroughly seasoned. Slight changes have been made in the requirements for label holders. The use of wire screen for the back of letter cases is no longer permitted. The details of letter cases are shown on railway mail service drawings, Sheet 50, which supersedes Sheets 1, 2, 3 and 4 and Sheet 5, Fig. 3.

Minor changes are made in the requirements for racks. The specification for package boxes and boxes for papers states that when the deck of a mail car is of such width that the top of boxes for papers projects more than 5 in. into the deck opening, the top of that portion of the boxes projecting into the opening shall be covered with wire screen of not less than ½-in. mesh. When the boxes project less than 5 in., the fronts of the boxes at the top are to be beveled sufficiently to prevent the obstruction of light and to avoid a shelf on which dust can accumulate. The beveled front may be of wood or metal. Cages for registered mail were formerly required to be made of wire netting, but they may now be constructed of wire netting or perforated metal. The installation of a gas plate or a steam cooker and a portable cot is no longer required.

The specifications for catcher arms have been changed by adding the requirement that the round rod used in the arm must be made of open hearth steel of not less than 0.40 or more than 0.60 per cent carbon content. The bracket for the catcher arm applied to the side doors shall be located not less than 3 ft. 9 in. from the floor.

A Blue Print Bath

BY A. G. JOHNSON

Mechanical Engineer, Duluth & Iron Range, Two Harbors, Minn.

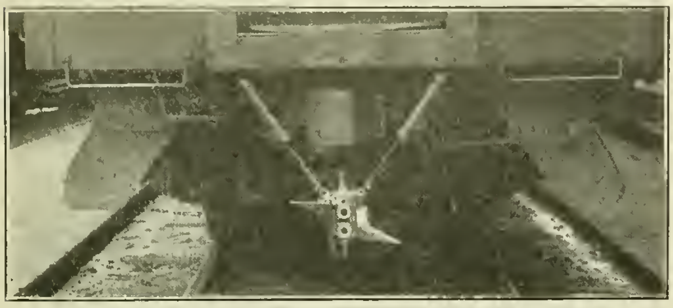
A solution of one ounce of bichromate of potash to three gallons of water makes an ideal bath in which to wash blue prints, as it will darken the color and fix the chemicals so the prints will not fade. The print must be exposed slightly longer than when clear water is used and it is well to rinse after removing from the bath. The solution can be used indefinitely by replacing the water that evaporates and, when running water is not available, it is almost a necessity.

It is always well to have a bichromate solution handy in any blue print room for use in bringing back over-exposed prints, in which case the best practice is to first wash the print in clear water for a few minutes and then immerse it in the bichromate bath and rinse. Nice clear whites will result.

The Futrell Automatic Train Line Connector

New Type Suspension, Positive Lock for Connector Heads and Removable Gasket Plate Are Features

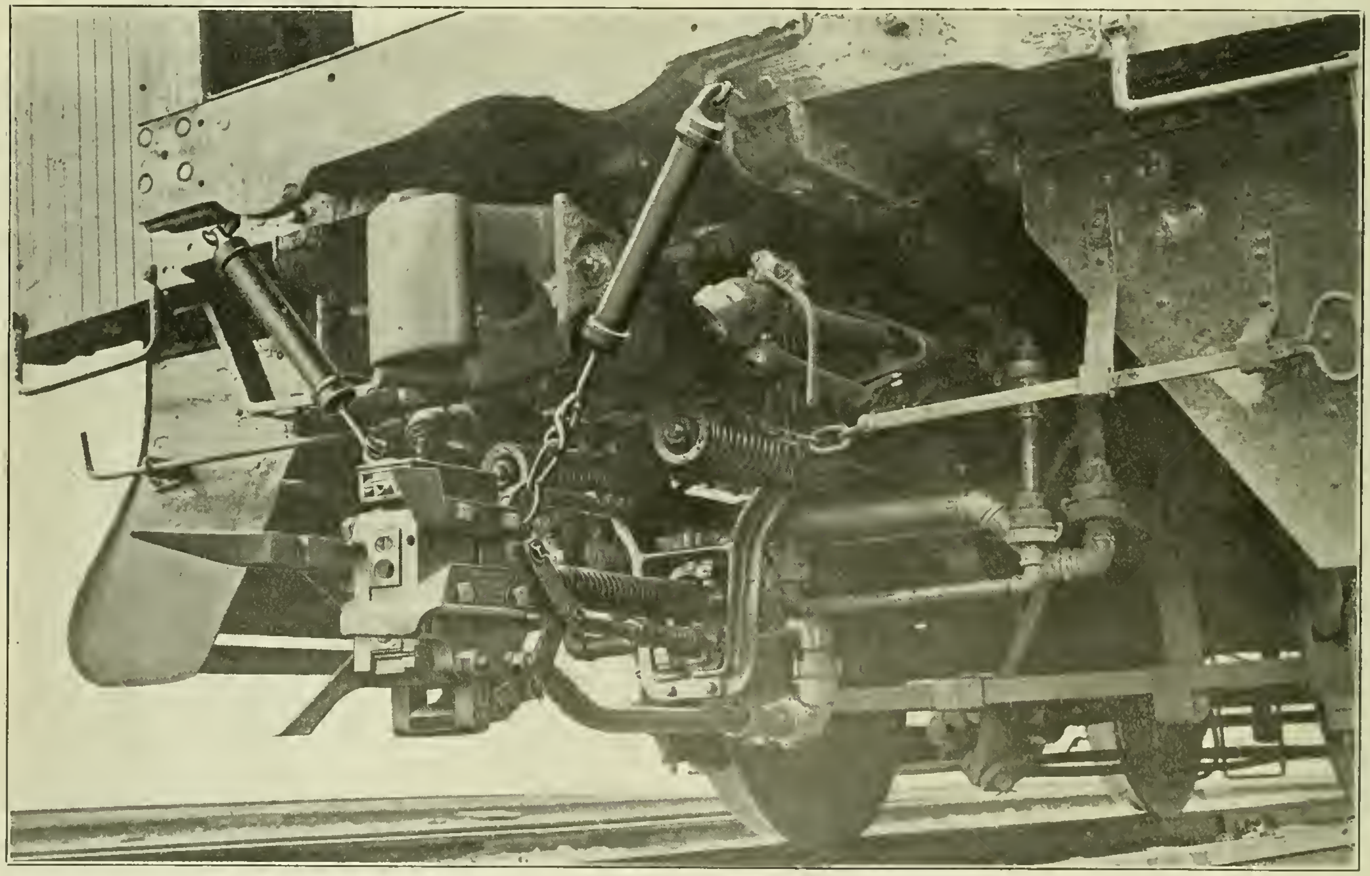
DURING the past 18 months the Baltimore & Ohio has had in service on a local passenger train a new design of automatic connector. This device, which is the invention of Thomas J. Futrell, is made by the Futrell Coupler Company, Streator, Ill. While the construction follows the general principles of some of the existing types, there are several unique features, the most notable being the arrangements for locking the heads and taking care of movement between coupled cars.



End View of a Car Equipped With the Connector

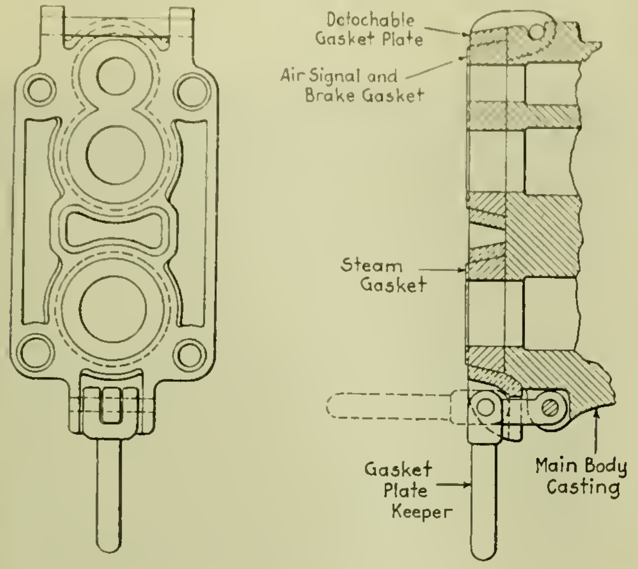
The coupler, as shown in the illustration, is of the butt-face, wing type. The head casting is suspended beneath the coupler by diagonal wire cables which are supported by an enclosed spring mechanism from the car body. A bracket is attached to the center sill behind the coupler carrier iron and a yoke shaped lever, pivoted to the bracket, supports a stem which extends from the rear of the coupler head. Two springs attached to the bracket force the yoke forward and another spring is applied to the stem of the coupler head. These parts are adjusted so that the connector when not coupled extends 5¾ in. ahead of the pulling face of the coupler knuckle.

Beneath the main stem of the connector is an auxiliary stem with a spring adjustment. This stem operates a lock through a toggle arrangement and after the connector faces are in contact the lock is caused to engage a slot in one of the wings as it mates with the coupler head. The details of operation of the locking arrangement are clearly shown by drawings of the side and front views of the head. In a recess in the head beneath the left side wing is a segment, *a*, pivoted near the upper edge. The portion of this segment lying within the head serves as a stop for the locking bar, *b*. The lower outer edge of the segment extends into the guide in which the wing of the opposing connector engages the head. Thus as the wing moves in it will force the segment upward and release the locking bar, which is then free to enter the slot in the wing. When the connectors are separated the locking bar is returned to the lower position and the segment, being released as soon as the wing is removed, returns to its original position by gravity.



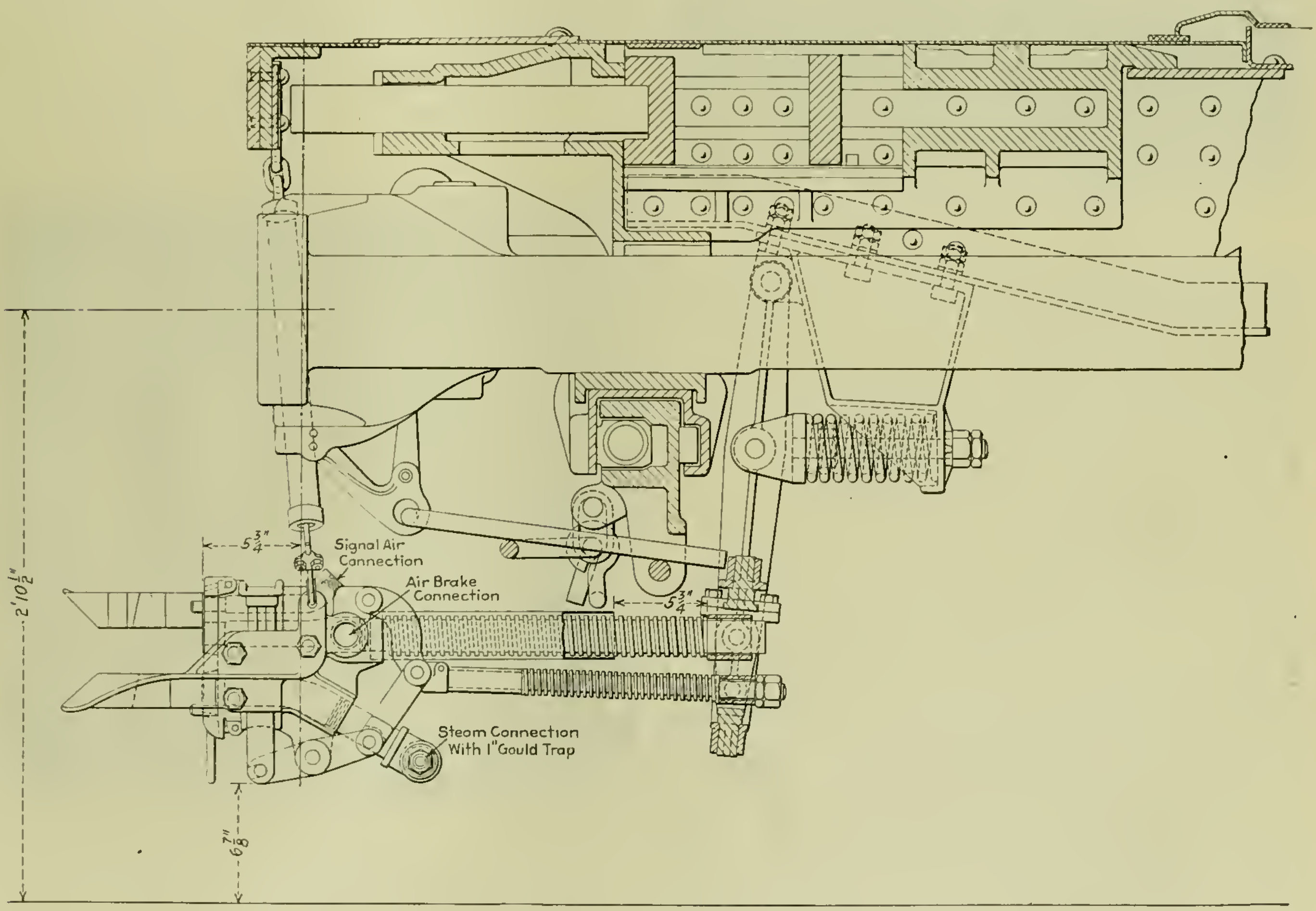
The Futrell Connector, Showing Suspension, Piping and Electric Contacts

The heads, when locked, form practically one solid part and since the connectors are supported from the car body, it is necessary to provide sufficient freedom of movement to insure that no additional stresses are placed on the heads by the relative movement between the ends of adjacent cars.



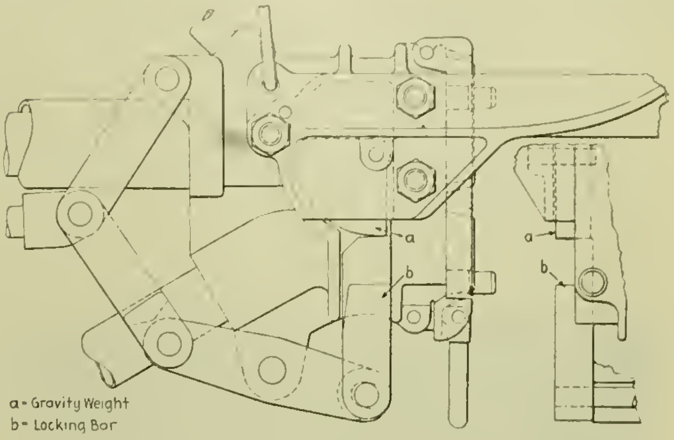
Details of Removable Gasket Plate

The yoke shaped lever, being pivoted at the upper end, is free to move forward or backward to take up motion resulting from the compression of the drawbar springs and a trunnion casting between this lever and the stem of the coupler head provides for lateral and vertical movement.



Side Elevation of the Connector Head and Suspension

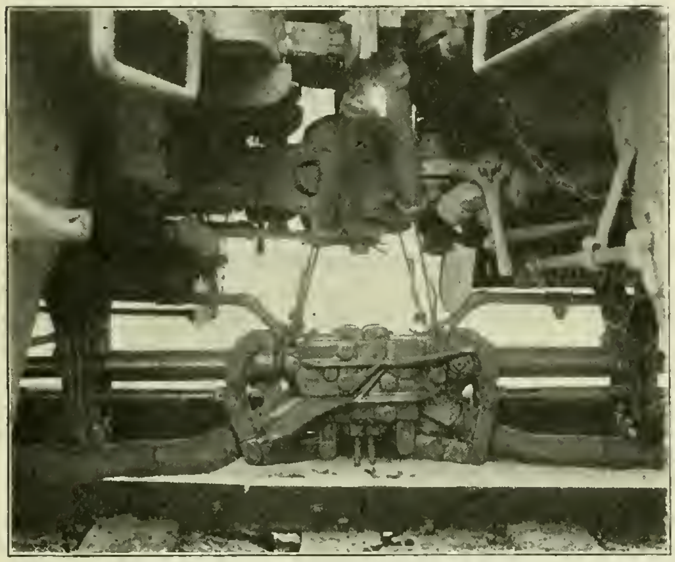
The wing type gathering mechanism has a vertical range of 7 in. and a horizontal range of 7 in. On the earlier designs, four wings were used, but the latest type has but two. An additional means of insuring perfect alinement in the head is provided by two pins in the face which register with recesses in the opposing connector head. As is the usual practice in this type, the ports are located on the vertical center line, the air signal connection being at the top; the air brake in the center and the steam heat at the bottom. The sizes of the openings are as follows: air signal ⅞ in.; air brake 1⅜ in.; steam heat 1½ in.



Side View of Head Showing Locking Mechanism

The gaskets are held in place by a detachable gasket plate fastened to the front of the head. The plate is hinged at the top and is locked at the lower end by a cam which forms part of the gasket plate keeper. In order to remove the gasket plate, the handle must be raised to the position shown by the dotted lines. When the two connectors are coupled, the handle is held in the vertical position and there is no possibility of the plate becoming unfastened. It will be noted from the illustration that the gaskets are tapered to fit the plate and the air brake and signal ports have a single gasket in common. With slight changes in the gasket holder, A.R.A. standard air hose gaskets could probably be used. In the design of the head, provision has been made for the attachment of electrical connections at the top of the head casting.

All connections between the connector head and the train line are made by pipe and flexible joints, both the Barco and McLaughlin type being used. In order to make the connections to the head, tees are inserted in the train lines behind the angle cocks. Ordinary air cocks are used in the air connections and a quick opening throttle valve in the steam passage. The levers for the operation of these cocks are placed toward the center of the car just behind the steps, where they can be reached from the side without going between the cars. The piping and cocks to which the rubber hose are connected are not disturbed in the installation of the coupler and for that reason no other provision is made for interchanging with equipment fitted with the standard connections.



A Side View of the Connectors in the Coupled Position

Journal Packing Reclamation

Journal packing represents a considerable item of cost in car maintenance. Various roads have developed different methods of reclaiming packing removed because of cut-journals, hot boxes or in the course of ordinary repairs. The method illustrated and described in this article has been devised and tried out with exceptionally good results.

The journal packing as received at the oil house is placed in the large vat shown in Fig. 1, in the bottom of which are steam coils. As it is "cooked" in the oil boiled out and left from previous boilings, the packing is stirred around from time to time. During this stage of the operation, much of the dirt, grit, babbitt, etc., is worked out, after which the warm, spongy packing is transferred to the table of an air press, shown at the end of the boiling vat. This press has a cylinder about 30 in. in diameter and exerts a pressure of approximately 35 tons, effectively squeezing out any oil remaining in the packing, the oil draining off through the base of the press and the molasses gate seen near the front of the press.

This oil, together with that secured in the boiling vat, is filtered thoroughly through a three-stage water filter illustrated in Fig. 2, the operation of which is as follows: With all tanks full of water to their respective overflow points, oil is poured into the right hand tank and overflows down the first pipe. The difference in head is sufficient to force the oil and water ahead of it down the first overflow pipe and into the bottom of the second tank, a movement which continues as long as oil is poured into the first tank. Being lighter than water, the oil rises slowly in finely divided parts through the water in the second tank to its overflow pipe. As the oil rises, solid particles of dirt and grit, heavier than water, separate from the oil and sink to the bottom of the tank. This operation of filtering the oil continues through the three stages when it is finally drawn off from the bottom of the last tank. As occasion demands, each tank is cleaned by opening the gate at the bottom and drawing off enough water to remove all sediment and collected dirt.

Fig. 1—Sheet Iron Boiling Vat Used in Initial Removal of Dirt and Babbitt from Journal Packing

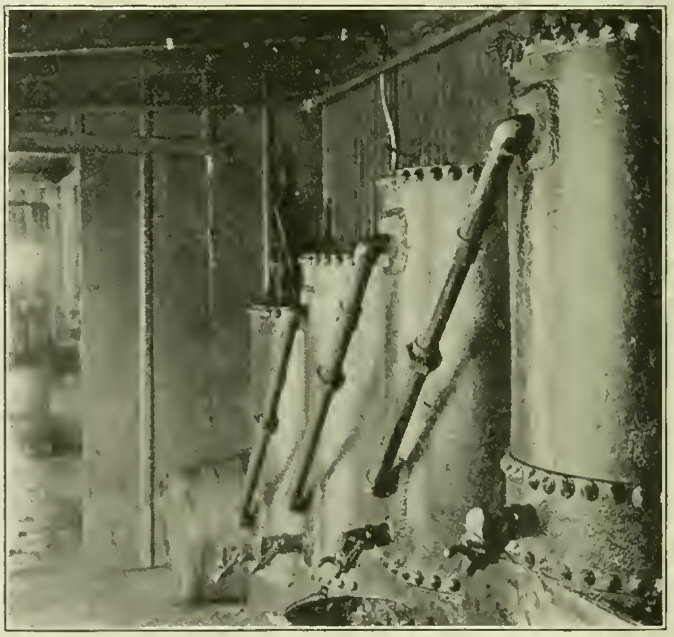


Fig. 2—Three-Stage Water Filter for Cleaning Oil

The dry wool waste is taken to a screening table with a diamond shaped screen opening, the length of each side being $1\frac{1}{2}$ in. Being thoroughly forked over this screen, all short lengths are worked through as well as any dirty residue. The resulting waste and filtered oil are used without addition of new material in making up packing for freight car equipment.

The Use of Wood in Freight-Car Construction[*]

Relative Merits of Steel and Wood for Open and Closed Top Cars—Use of Graded Lumber

By H. S. SACKETT
Assistant Purchasing Agent, Chicago, Milwaukee & St. Paul

THE fact that over two billion feet of lumber and timber are used annually in the United States for the maintenance of freight equipment and for the construction of new cars, representing an annual outlay for material alone of over $50,000,000, is ample evidence of the importance of wood in this big industry.

The first freight cars used for railroad transportation in this country were built of wood and this great natural resource has been an important factor in their construction ever since. In recent years steel has competed with wood, especially in the construction of gondola and other types of open-top cars, but whether this change has been an economical one or not remains a question.

From recent studies made of the subject by disinterested commissions, the indications are that even for open-top cars, wood is still the most economical material. With the growing scarcity of timber, however, and the apparently unlimited supply of steel available, it is probable that this latter material will always be a prominent factor in the construction of cars, and especially so, if some agent is found to reduce materially the present high rate of loss from rust and corrosion.

In the construction of the first cars wood was almost universally used for all parts, except of course the running gear. Within the past decade, however, with the introduction of heavy motive power, which spells long and heavy trains, it has been found that wood is no longer capable of withstanding the heavy shocks incident to such operation, and it is generally conceded by all car builders that the freight car of the future must be of steel underframe and steel draft rigging.

This limits the use of wood to unimportant parts of the underframe, such as intermediate sills and cross-beams, and to the superstructure of the car. In the case of open-top cars this means only posts and side and end plank and decking, but in box, stock, and furniture cars, etc., it means also siding, lining and roofing.

Steel vs. Wood for Open-Top Cars

To take up the question of open-top cars first, statistics gathered by operating officials of some of the larger railway systems seem to indicate that the cost of maintaining steel gondola cars over a period of years is greater than for composite (wooden and steel) cars of the same type. The data[1] collected show that all-steel gondola cars in their twelfth year of service cost over 36 per cent more to maintain than did the composite gondola. Of course, it is probable that during the first five years of its life the steel gondola cost less to maintain, but it is felt that taking the entire twelve years as an average, the cost would be more for the maintenance of the steel than the composite gondola.

It is furthermore interesting to note that but 60 per cent of the composite gondolas in service required repairs, while 72 per cent of the steel gondolas were obliged to be brought to the shops. The actual time that a car is in service and earning money for the road is an important consideration in determining its general utility. It is also interesting to note the conclusions in favor of the composite gondola, which are as follows:

> The initial cost of the composite gondola with the present price of steel is less than the all-steel gondola.
>
> The composite type of car costs less to maintain than the steel gondola.
>
> The sides of the composite car do not bulge as do those of the steel car.
>
> The records show that while the composite car costs more to repaint than the steel car, it does not require painting as frequently.
>
> A large portion of the repairs to composite cars can be taken care of at other than steel-car shops.
>
> Certain properties in coal cause corrosion to steel, and wood is not affected by them.

Table 1 shows the annual cost of repairing freight cars since 1908. It will be noted from this table that the cost of repairs per car has increased from $59.30 in 1908 to $80.30 in 1914, an advance of over 35 per cent. This higher cost is due, of course, to a number of factors, but it is felt that no small part of it is due to the use of steel, which requires a greater outlay for material and a higher cost to repair, owing to the fact that it takes longer to make like repairs on a steel car than on a wooden one. It must also be borne in mind that this higher cost is very largely due to the much rougher usage to which freight equipment is now subjected. In recent years the freight business of the railroads has grown enormously, and has necessitated the construction of gravity yards for switching, and the use of fewer switchmen per cars handled than in former years. This has resulted in severe handling of freight equipment, and is probably responsible to a greater degree than any other factor for the increased cost of repairs in recent years.

TABLE 1—ANNUAL COST OF REPAIRING FREIGHT CARS

Year	Number of freight cars	Cost of repairs per car	Ton-miles per $1 repair cost	1,000 ton-miles per freight car
1908	2,089,302	$59.30	1,762	104.5
1909	2,073,606	59.70	1,768	105.5
1910	2,135,121	65.60	1,821	119.5
1911	2,117,644	65.10	1,815	117.9
1912	2,140,687	65.50	1,858	121.5
1913	2,209,533	74.70	1,802	134.6
1914	2,263,015	80.30	1,565	125.8

Steel vs. Wood for Closed-Top Cars

In the case of closed-top cars, such as, for example, stock, box, and furniture cars, there is but little doubt that under present railroading conditions the understructure should be of steel with a wooden superstructure. The steel understructure is required to withstand the shocks of service and to give rigidity and stability to the car, while the wood is desired to give lightness and general utility to the body. Some all-steel box cars are in use today, but their heaviness and the fact that nails and cleats cannot be used in them to brace and hold the lading, are strong factors against the use of this material. It has not met with favor with shippers generally and probably will not as long as wood continues to remain available. No material has yet been discovered which combines the properties of strength, lightness, availability, and ease of working such as possessed by wood, and until

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[*] Abstract of a paper presented at the annual meeting, New York, December, 1920, of the American Society of Mechanical Engineers.

[1] Paper by Wm. Queenan, assistant superintendent of shops, C. B. & Q.

such a material is developed and made available, wood will undoubtedly continue to be universally used for the superstructure of freight cars.

The dead weight of cars is also an important factor in considering the cost of and earnings from freight haul. There is no doubt but what the excessive weight of the all-steel car has been one of the most deterrent factors to its general adoption in freight-car construction, and this fact, together with its lack of readily available repair parts and the large expenditure required to equip shops to efficiently handle all-steel equipment, has combined to retard and limit its use.

Graded Lumber in Car Construction

It seems pertinent to say a word at this time as to the grades of material required for the different parts of the body of the car. In the early days when the supply of wood in this country was thought to be inexhaustible, clear grades of wood were generally demanded by the car builders, and in the construction of new cars this is generally the practice at the present time, especially for car roofing and siding, sound-knotted stock being used for decking and lining. Some of the more progressive railroads, however, have gone a step further in recent years and many are now using sound-knotted stock for siding and roofing for repair and maintenance work. There is no doubt but what such a practice is economical and based on sound judgment, for certainly there is no necessity for using clear material for the repair of many classes of freight equipment, the life of which may not be in excess of seven to ten years. One large railway system which not only constructs its own cars but does repairing on a large scale, has adopted the following practice as to grades:

FOR NEW CARS

Siding	No. 2 Clear and Better Fir
Roofing (double board roof)	No. 2 Clear and Better and Select Common Fir
Roofing (metal-covered)	Select Common Fir
Lining	Select Common Fir
Decking	Select Common Fir

FOR REPAIR WORK

Siding	No. 3 Clear and Select Common Fir
Roofing	Select Common Fir
Lining	No. 1 Common Fir
Decking	No. 1 Common Fir

On this particular railroad the saving on this amended practice amounts to over $500,000 per year, and its economy is apparent.

As far as specifications for end sills, door and side posts, belt rails, etc., are concerned, practice varies widely among the various railroads. Some still insist on oak for such purposes, and others have gone to fir and pine. With the rigid steel underframe it is believed the use of soft woods is more justified than ever for posts and belt rail, but unless well protected with steel plates it is believed the use of oak end sills is still to be recommended. Oak and other hard woods are becoming more scarce and higher in price each year and it is felt that the general practice very shortly will be pine or fir end sills properly reinforced with steel.

Some Advantages of Wooden Cars

An important feature of car construction which is decidedly in favor of wood, is its general ease of working and adaptability to repair, and this is brought about not only from its qualities, which make it easy to cut, saw and shape, but also by its almost universal availability. We have been a wood-using nation for over a century, and artisans familiar with its properties and able to work it are always at hand.

It is also rather curious that the salvage value of wooden cars is greater than that of steel cars, and no one doubts this who has seen the two types of cars in a seriously wrecked condition. The wooden car may be quickly and easily repaired, while the steel car is only rehabilitated at a high cost, or for the most part is fit for the junk pile.

The Importance of Well-Seasoned Wood

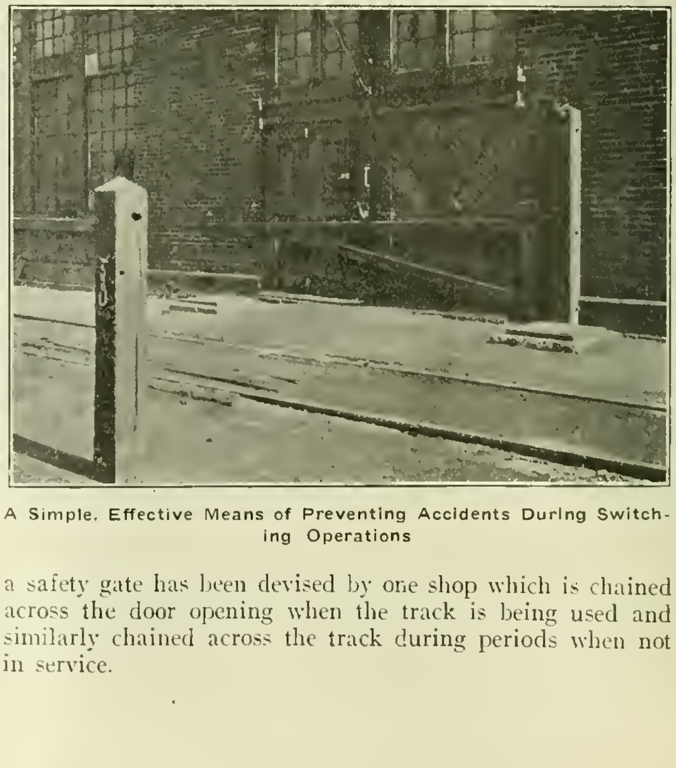
Before using wood in the building of freight cars it is vitally important that it be well seasoned. When our grandfathers built a house they expected it to last a century, and it usually did, for they took great care to properly season the wood before putting it to use. In the houses nowadays, however, we use wood almost before it is dry from the saw, and the result is that our American frame houses today are old at 15 or 20 years and we do not get anywhere near the service out of the wood that we should. Too often today we also see freight cars built of green lumber and timber, with the result that within a few months the bolts are loose, the wood having shrunk away from the original fastenings. This causes rapid deterioration and large timbers often quickly rot, particularly those containing sapwood.

It is safe to say that every railroad in the country should at all times carry on hand an 18 months' supply of oak and other hard woods and a 12 months' supply of fir, pine, and other soft woods. All this material when received should be properly piled for air seasoning, and in the case of clear material used for important parts, such as car siding, should be run through the dry kiln just prior to use.

Increasing attention has been given in recent years to the preservative treatment of certain parts of freight cars, and experiments have been made by some of the more important railway systems in the treatment of such items as stock-car decking, side and intermediate sills, roofing, etc. While these experiments have not been conducted for a sufficient length of time to determine actual results, the indications are that the preservative treatment of such car parts as are particularly liable to decay is profitable and will shortly be adopted as standard practice by the more progressive railroads. The conclusion is inevitable that the superstructure of freight cars will continue to be of wood as long as it is available at a reasonable price.

Shop Safety Gate

Many railroad shops are built upon such restricted properties that switching tracks are located close to shop buildings. This makes a dangerous condition when shop doors open out upon these tracks. To eliminate possible accidents, a safety gate has been devised by one shop which is chained across the door opening when the track is being used and similarly chained across the track during periods when not in service.



A Simple, Effective Means of Preventing Accidents During Switching Operations

Designing Brake Heads for Uniform Shoe Wear

Principles Applicable to Heads Used On Wheels Revolving in One or Both Directions

BY H. M. P. MURPHY

ALTHOUGH the unequal wear of brake shoes is frequently caused by imperfections in the metals employed in their manufacture and also by the use of improper forms of suspension hangers for brake beams, one of the chief causes of this undesirable result is the incorrect location of the hanger eye and the brake beam socket in the brake head. In order to overcome the last mentioned evil and thus to obtain uniform shoe wear as nearly as practical conditions will permit, the following methods should be employed whenever possible in the design of brake heads.

Methods for Determining the Leading Dimensions of Brake Heads

For reasons which will appear later, two cases must be considered in the design of brake heads, one applying to heads used on ordinary railway cars which run equal distances in both directions and the other applying to "single end" locomotives and motor cars which run practically in one direction only. Before discussing these two cases, the general conditions and dimensions which will be employed must first be outlined. In Fig. 1, the standard A. R. A. brake head and shoe are illustrated. The line, *EF*, represents the middle radius, or center line, of the shoe, the arc, *MN*, represents the shoe surface when the shoe is half worn (the wear being assumed as uniform), and the point, *f*, represents the middle point of the average wearing surface of the shoe; these same designations will be used in connection with the subsequent sketches and descriptions. Moreover, in Fig. 2, *W* represents the wheel center, *R* represents the radius of the wheel and *C* represents the vertical distance between the center, *W*, and the point, *g*, of the wheel tread with which the point, *f*, of the shoe is to coincide; or, in other words, *C* represents the vertical height between the horizontal center line of the wheel and the average central point, *f*, of the shoe.

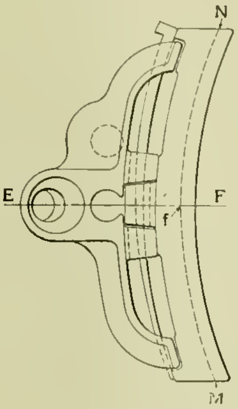


Fig. 1

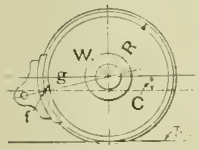


Fig. 2

The value of *C* as recommended by the Mechanical Division of the American Railway Association is approximately 3½ in. for cars. The symbols *C* and *R* will be employed hereafter to designate the dimensions indicated in Fig. 2.

CASE 1: *This case applies to brake heads to be used for wheels rotating equally in both directions.*

In order to obtain uniform shoe wear the following instructions should be observed: *The hanger eye* may be located at any point in the head providing that the hanger is of sufficient length to maintain an approximately constant angle with the center line, *EF*, Fig. 1, of the shoe, but as hangers are usually too short to produce this effect, the recommended location of the eye is directly on the center line *EF*, see Fig. 3.

The brake beam eye, or socket, should be located at some point on the line, *hk*, Fig. 3, the point, *h*, denoting the point of intersection of the center line, *EF*, and the center line of the hanger, whether the hanger eye be located as previously recommended or not. As indicated in the figure referred to the line, *hk*, is required to make the angle, *A*, with the center line *EF*, and it should be noted that this angle must be laid off towards the *top* of the shoe in every case, that is, the brake beam eye must be located on the line, *hk*, *above* the center line, *EF*, of the brake head. The value of the angle, *A*, depends on the radius, *R*, of the wheel and the vertical depression, *C* (see Fig. 2), of the central point, *f*, of the shoe. To determine the angle, *A*, when the values of *C* and *R* are specified, find the quotient of *C* divided by *R* and then refer to Table I, where the corresponding value of the angle, *A*, will be readily found.

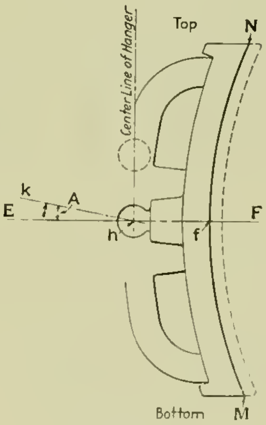


Fig. 3

Application of the Method

Example 1: To illustrate the method just described, let it be required to find the angle, *A*, which the line, *hk*, should make with the center line, *EF*, of the brake head (see Fig. 3) when the radius, *R*, of the wheel is 16½ in. and the vertical distance *C* (Fig. 2) is 3½ in.

Solution: To solve this problem divide *C* by *R* thus,

$$\frac{C}{R} = \frac{3.5}{16.5} = .212$$

By referring to Table I, it is seen that value of *A*, corresponding to this value (.212) of C divided by R, is 12¼ degrees, that is, $A = 12\frac{1}{4}$ degrees.

As the conditions of the preceding problem are those pertaining to the standard 33-in. car wheel and recommended location of the brake head, it is apparent that when the brake beam socket is located close to the hanger eye, the difference between the standard A. R. A. brake head, shown in Fig. 1, and that designed by making the angle A equal to 14¼ degrees is not of very great importance, but on the other hand if the brake beam socket is not located close to the hanger eye the difference may become quite worthy of consideration. The chief use of the foregoing method is, however, found in the case of "double end" locomotives where the distance C is often very great compared to R and, therefore, where the angle A has a correspondingly large value.

TABLE I

Table Giving the Proper Location of the Brake Beam Eye in Brake Heads on Cars and Locomotives in Order to Produce Uniform Shoe Wear

Value of Angle A, in Degrees, Corresponding to Various Values of C Divided by R

C/R	A	C/R	A	C/R	A	C/R	A
.0000	0	.0872	5	.1737	10	.2924	17
.0044	¼	.0915	5¼	.1779	10¼	.3007	17½
.0087	½	.0959	5½	.1822	10½	.3090	18
.0131	¾	.1002	5¾	.1865	10¾	.3173	18½
.0175	1	.1045	6	.1908	11	.3256	19
.0218	1¼	.1089	6¼	.1951	11¼	.3338	19½
.0262	1½	.1132	6½	.1994	11½	.3420	20
.0205	1¾	.1175	6¾	.2036	11¾	.3502	20½
.0349	2	.1219	7	.2079	12	.3584	21
.0393	2¼	.1262	7¼	.2122	12¼	.3665	21½
.0436	2½	.1305	7½	.2164	12½	.3746	22
.0480	2¾	.1349	7¾	.2207	12¾	.3827	22½
.0523	3	.1392	8	.2250	13	.3907	23
.0567	3¼	.1435	8¼	.2335	13½	.4067	24
.0611	3½	.1478	8½	.2419	14	.4226	25
.0654	3¾	.1521	8¾	.2504	14½	.4384	26
.0698	4	.1564	9	.2588	15	.4540	27
.0741	4¼	.1607	9¼	.2672	15½	.4695	28
.0785	4½	.1651	9½	.2756	16	.4848	29
.0828	4¾	.1694	9¾	.2840	16½	.5000	30

Case 2: *This case applies to brake heads to be used for wheels intended to rotate in one direction only.*

In order to obtain uniform shoe wear the following instructions should be observed: *The hanger eye* should be located on the line, fH, Figs. 4 and 5, which makes the angle, B, with the center line, EF, of the brake head. This angle, B, depends on the *average* running speed of the car or locomotive and may be determined directly by aid of Table II. In all cases B must be laid off in the direction in which the contact surface of the wheel moves, that is, in the direction of rotation, as indicated in Figs. 4 and 5. The point, H, located on the line fH, having been fixed at any specified distance from f, should, of course, represent the center of the hanger eye, but if a long hanger is employed the eye may be located at some other point on the center line of the hanger providing that its distance from H is not excessive.

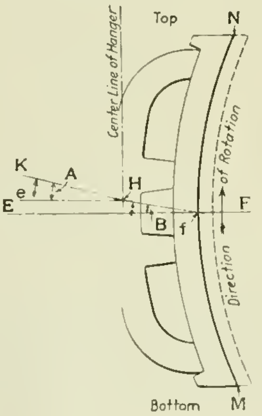


Fig. 4

Example 2: To illustrate the method of determining the angle B by aid of Table II, let it be required to find the value of B for a brake head to be used on the wheel of a "single end" car which has an average maximum speed of 30 m. p. h.

Solution: As the average running speed should be considered as one half the value of the average maximum speed, the former, in this case, will be ½ x 30 or 15 m. p. h., whence by referring to Table II it is seen that the angle B should be equal to 12¼ degrees.

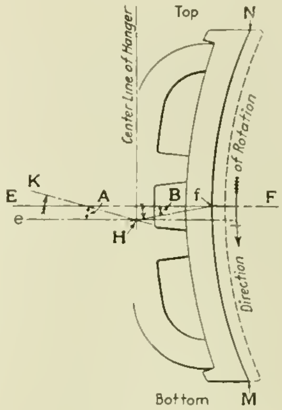


Fig. 5

The brake beam socket or eye should be located on the line, HK, Figs. 4 and 5. To determine this line, HK, draw the line eH parallel to the center line, EF, of the brake head and lay off the angle, A, towards the *top* of the shoe in every instance, as indicated in Figs. 4 and 5. The angle, A, depends on the radius R of the wheel and the vertical depression C (see Fig. 2) of the central point, r or g, of the shoe, and may be determined by aid of Table I in the same manner as that employed in Case 1.

TABLE II

Table Giving the Proper Location of the Brake Shoe Hanger Eye for Brake Heads, on Cars and Locomotives Adapted to Run in One Direction Only, in Order to Produce Approximately Uniform Shoe Wear

Average running speed in miles per hour	Values of Angle B in degrees	Average running speed in miles per hour	Values of Angle B in degrees
5	14¼	35	9¼
10	13¼	40	8½
15	12¼	45	7¾
20	11¼	50	7
25	10½	55	6½
30	9¾	60	6

Finally, it should be observed that, when the proper location of the brake beam socket (or eye) is specified as being "on a certain line," as HK, Figs. 4 and 5, or hk, Fig. 3, it must be understood that the line in question is to be the center line of the socket, that is, the socket must be constructed with respect to this line in the same manner as the socket shown in Fig. 1 is constructed with respect to the line EF.

To Show Up minute cracks in hardened pieces, apply oil, wipe off, and chalk the surface. The oil appears at the cracks, soaking through the chalk.—*The Melting Pot.*

The Shops, like other branches of the transportation system, were turned back to their owners in a bad state of demoralization, so that a great amount of work has been contracted for outside. It has actually been found both cheaper and quicker to reconstruct equipment in other than the railroads' own shops. Under political administration of the railroads a repair shop appears to have been a good deal of a loafing place.—*Providence Journal.*

Cylindrical Grinding in 1920*

BY W. H. CHAPMAN

Norton Company, Worcester, Mass.

This paper comprises a study of the laws involved in cylindrical grinding and an analysis of grinding action (1) for draw-in cuts and (2) for traversed cuts.

Grinding efficiency is usually considered as (production) ÷ (wheel wear). Accordingly formulas are derived for wheel wear in terms of grain size of wheel, work speed, wheel speed, feed, etc. By calculating values for wheel wear for different conditions and comparing them with production figures calculated under the same conditions, a proper selection of wheels may be made.

The fact that wheel wear is a comparatively unimportant item in the total cost of grinding, however, frequently leads to wrong conclusions if this is made the controlling factor. The all-important factor is the rate at which the wheel may be made to cut and still not get out of truth. Assuming wheel cost to be, for example, 7 cents per cu. in. and other production costs 5 cents per minute, production efficiency is materially increased by increasing production at the expense of wheel wear within defined limits. The paper concludes with a series of practical conclusions, the most important of which is that increase of traverse speed increases production without increase of wheel-wearing action.

The Job of Being a Foreman

As a foreman what is your goal—the pay envelope or the satisfaction of getting team work and quality and quantity production from your department? Do you regard your work as a job or as a profession?

How much time do you give to thought and study with a view to improving the relations between the workers and the management? What do you know about production management?

These are plain questions and your answer to them will measure your worth to the railroad and in a larger sense to the community.

Is there a real reason why foremen generally in railroad service have been paid comparatively low rates?

The author makes a mathematical analysis of grinding action for draw-in (non-traversed) cuts from which he derives the following laws of cylindrical grinding, operative *within the usual limits of speeds and dimensions.* For straight-in (draw-in) cuts a free-cutting wheel will wear according to the effect of wheel-wearing action as outlined below:

(a) Wheel-wearing action increases directly as: 1. Grain interval (grain size—inversely as grade). 2. Work speed (surface). 3. Square root of diametral cut (feed).

(b) Wheel-wearing action increases directly as the following are decreased: 1. Square of wheel speed (surface). 2. Square root of work radius.

A soft wheel is more susceptible to wheel-wearing action than a hard wheel and will more nearly follow the theoretical conditions. It is therefore more free-cutting and will cut more nearly the full chip than a hard wheel. There is consequently a gain in production as wheels of softer grades are used, all other conditions remaining constant, up to the point where the chips are geometrically perfect for a given condition of speeds and dimensions. It is clear from this standpoint that the softest possible wheel should be used. High wheel speeds up to the safe limit are of course necessary if the soft wheels are to perform in a satisfactory manner.

Traversed Cuts

The most important development in recent grinding machines is the recognition and utilization of the fact that overall operating efficiency for traversed cylindrical work *increases as traverse speeds are increased.* (This assumes that for a given traverse speed, width of wheel and revolution of work are so related as to cause the cutting face to just cover the lead of the work.)

From another theoretical analysis the following laws of grinding for traversed cuts are deduced:

(a) Wheel wear increases directly with every increase in the work speed.

(b) Wheel wear decreases directly as the decrease in the quantity which we term "traverse factor," which is work speed divided by the square root of the sum of the squares of traverse and work speeds.

(c) Wheel wear decreases directly as square of wheel speed increases.

(d) Wheel wear decreases directly as the square root of the work radius increases.

(e) Wheel wear increases directly as the square root of the feed increases.

Production Costs

Grinding efficiency is usually considered as (production) ÷ (wheel wear). It is expressed as cubic inches of material removed per cubic inch of wheel wear. If wheel wear were

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*Abstracted from a paper read at the December, 1920, annual meeting of the American Society of Mechanical Engineers.

the most important element of production cost, grinding efficiency might be considered on this basis without leading to the fallacy which exists today. As a matter of fact, the wheel cost is almost negligible compared to the other costs, and wheel selection should be based upon the production capacity of the wheel under the given set of grinding conditions, allowing the wheel wear to be as high as is necessary to get a free action without excessive wear (which would cause difficulty in sizing work and the need for frequent dressing). The all-important factor is the rate at which the wheel may be made to cut and still not get out of truth. This affects the grinding time, any reduction of which is of vastly more importance than an increase of wheel wear which may result from such a reduction.

The overall production efficiency of the machine based upon all costs involved is indicated by production-cost factors proportional to the earning rate of the machine.

In Table I the production-cost factors are given for 1-in. and 4-in. diameters of work only. The factors may also be expressed as earnings per unit of time, or the relative amounts the machine would earn in equal lengths of time under the various conditions as given.

Note that, due to high traverse, a 2.3-in. wheel which earns $3.68 in a certain length of time when grinding 1-in. work at low traverse and work speeds, will earn $10.62 in the same length of time when using the high speeds. If the widest wheel (7.35-in. face) be used the machine will earn $11.70 in the same length of time. The grade of wheel is suitable in each case according to the speed changes. This clearly shows that high traverse speeds cause a corresponding increase in earnings in spite of the necessary increase in work speed.

Table I—Production-Cost Factors

Table speed, ft. per min.	Work, r.p.m.	Lead, in.	Diameter of work	
			1 in.	4 in.
10.02	53	2.3	3.68	13.45
14 00	53	3.1	5.16	18.80
14.00	72.5	2.3	4.95	17.85
17.00	53	3.8	6.00	21.00
17.00	72.5	2.8	6.00	21.80
17.00	87	2.3	5.85	22.00
19.70	53	4.4	6.40	23.70
19.70	72.5	3.2	6.80	23.50
19.70	87	2.7	6.84	23.45
19.70	101	2.3	6.75	23.30
26.90	53	5.9	9.05	29.80
26.90	72.5	4.4	9.34	29.85
26.90	87	3.6	9.00	29.00
26.90	101	3.1	9.03	29.10
26.90	138	2.3	9.00	29.15
32.60	53	7.35	11.70	35.70
32.60	72.5	5.3	11.30	34.60
32 60	87	4.4	11.00	33.60
32.60	101	3.8	10.90	33.40
32.60	138	2.8	10.80	33.30
32.60	167	2.3	10.62	32.90

Considering the cost of wheels 7.35 in. wide as compared to wheels 2.3 in. wide, and the relative power required to drive the two wheels, it is very evident that the use of a harder wheel 2.3 in. wide would offset the difference in wearing action without greatly reducing production and that the production of the 7.35-in. wheel is matched by the production of the 2.3-in. wheel using highest traverse and highest work speed.

The most striking conclusion from the above is the fact that in order to use a narrow wheel and get great production the high work speed does not cause excessive wheel wear *due to the relief* on the wheel brought about by the *high traverse speed.* This traverse speed is also necessary to allow the rapid exposure of fresh work surface to the cutting face, making for a highly economical combination.

The author sums up the paper as follows:

In cylindrical grinding the following theoretical conclusions are found to hold true: Greatest grinding efficiency is obtained by the use of the softest wheels suited to the nature of the material ground. This efficiency is dependent upon the control of the dimension and speed relations between the wheel and the work so that the individual chip may have the minimum depth for a given volume determined by the maximum allowable radial depth of cut. This means long arc of contact, low work speeds and maximum feeds. With the above conditions established, *an increase of traverse speed increases the production without an increase of wheel-wearing action.*

Machine conditions must be such as to maintain as accurately as it is reasonably possible the speed and dimensional relations of the wheel and the work. This includes a great number of individual factors, any one of which may serve to entirely or partially impair the successful operation of the machine in following the theoretical fundamental laws as previously stated. It is worth while to emphasize some of the most important of these practical conclusions.

(a) The power drive must not allow speed variations unless under the wilful control of the operator.

(b) The wheel must be in good running balance and in absolute truth, and must be held in its position relative to the work within the closest possible limits.

(c) The work must be accurately held with respect to the wheel and must be uniformly rotated. Relative traverse between work and wheel must be uniform.

(d) The work must be rigidly supported over its entire length and no vibration allowed to occur between centers.

(e) The feed control must be sensitive and accurate and feeding must be at a rate such that the feed increment *never exceeds the maximum grain penetration,* which varies directly with grain interval, work speed, and square root of radial feed and inversely with wheel speed, and square root of work radius. (This is the most frequently violated of the factors involved.)

(f) The work must be kept at a uniform temperature and local heating prevented at all times. A copious supply of grinding compound should be directed to the arc of contact at all times. In truing the wheel with a diamond, the use of the cooling medium is vital to accuracy. Save the diamond by using a dresser to roughly true a wheel, and never feed a diamond over 0.001 in. per traverse.

(g) Select wheels intelligently, and do not try to use a single wheel for a variety of work sizes or materials unless the job is too short to warrant efficient grinding as compared with the time of changing wheels.

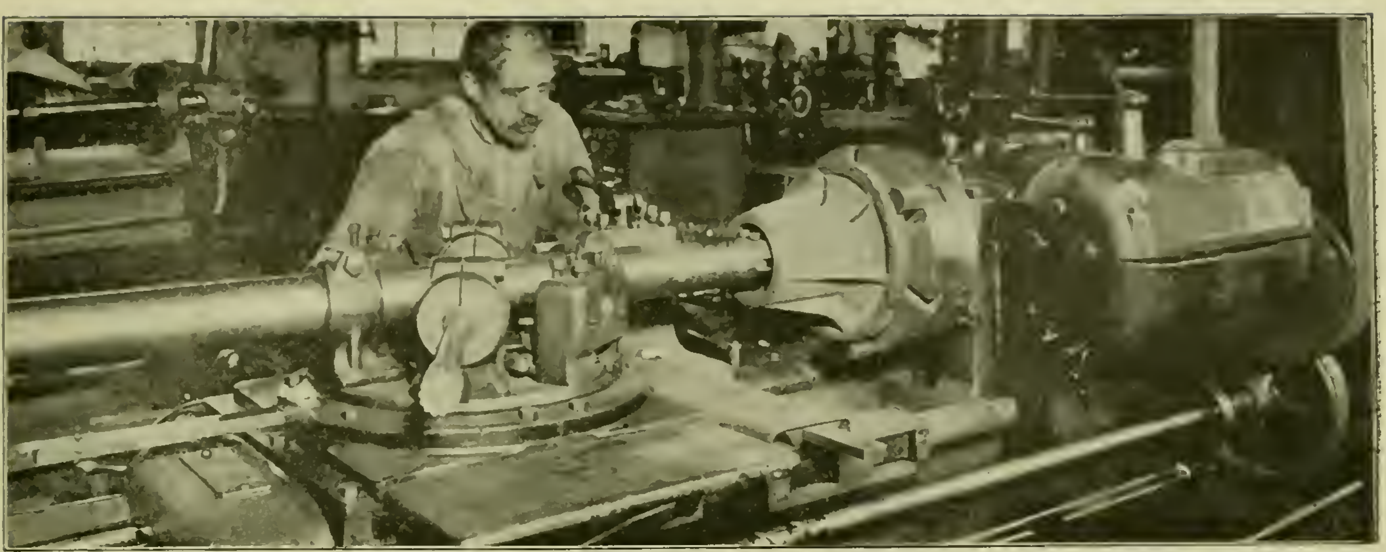
(h) An accurate finish requires the use of a soft, free-cutting wheel so controlled that the chips are very small. (Light feed and slow work speed with traverse to make the wheel face just cover the lead, should be used.)

(j) A burnished finish may be obtained by the peening action of a coarse, hard wheel trued dead smooth. Heating and inaccuracies of surface are likely to occur.

(k) Cases are rare where a wheel harder than grade M (Norton system of grades) may properly be used in cylindrical grinding. Low speed wheels, too small a wheel, too high a work speed and abusive feeding are usually the causes for the use of hard wheels.

(l) The contact of the wheel face with dry work at any time immediately ruins its value for finishing. The common practice of just touching the dry work when bringing up the wheel to contact is wrong, due to the charging of the wheel face with the uncooled chips (loading).

The Essential Requirements of tempering oils are: Flash and fire tests high enough to avoid serious evaporation loss or to incur high fire risk; comparative freedom from decomposition; absence of acid or acid forming substances, which would have a materially corrosive action on metals at high temperature; a fairly high heat capacity, and enough fluidity to permit rapid carrying away of the heat.—*The Atlantic Lubricator.*



Railroad Shop Turret Lathe Practice

The Turret Lathe; a Convenient and Efficient Tool for Accurately Machining Certain Locomotive Parts

BY HOWARD VOLZ
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THE machines referred to in this article are combination flat turret lathes and universal flat turret lathes with cross sliding turrets adaptable to bar or chuck work. The chief advantage of the machine equipped with a flat turret is its adaptability to any class of turning or boring operation and the simplicity of its arrangement. All the tools are used to the full capacity of the machine. The side carriage with the four-way tool post or square turret is one of the main features of the universal flat turret lathe and this combination makes the machine practically universal for all turning and boring work within its range.

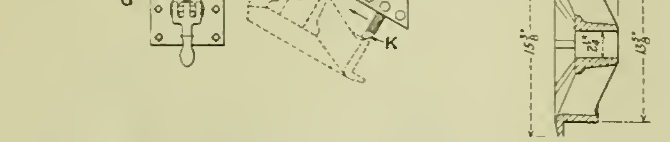


Fig. 1—Tooling Arrangement for Machining Valve Spider

Another advantage is the ease with which a turret lathe equipped for bar work can be changed over to one arranged for chucking work or on the other hand a chucking machine changed over to a bar machine. The following examples are special railroad jobs but typifying the work that can be performed on these turret lathes. Illustrations of tooling equipment used in each operation are given, as well as a detailed description of the entire sequence of operations.

Main Valve Spider

The valve spider illustrated in Fig. 1 can be machined complete on a No. 3 universal turret lathe in one chucking. The operations consist of finishing surfaces *A, B, C, D, E* and *F*. The work is held in a three-jaw chuck with high jaws cut out to hold the spider on the inside of the rim. Surfaces *A* and *C* are rough turned and surface *B* is faced by cutter *G* held in the square turret. At the same time, hole *F* is rough bored by cutter *H* held in a cutter bar in one end of a 3 7/16-in. boring bar at the first turret position. Surfaces *D* and *E* are faced by cutters *J* and *K* held in a tool plate or multiple tool holder at the second turret position. Surface *A* is finish turned by cutter *L* held in the square turret, and at the same time hole *F* is finish bored by cutter *M* in the cutter bar at the fourth turret position. Hole *F* is reamed by a reamer held in a tool holder at the fifth turret position, which completes all operations. Stellite cutters are used in the square turret. The time required is 12 minutes.

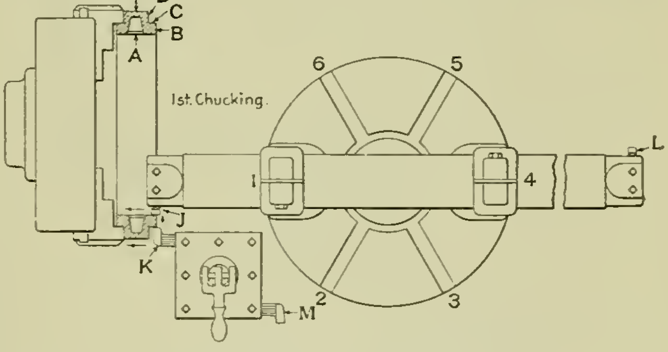


Fig. 2—Tooling of Universal Turret Lathe for First Operation in Machining Piston Valve Bull Ring

Piston Valve Bull Ring

Machining a piston valve bull ring in two chuckings on a

No. 3 universal turret lathe is illustrated in Figs. 2 and 3. In the first chucking surfaces *A*, *B*, *C*, *D* and *E* are finished. The work is held securely in a three-jaw chuck as shown in Fig. 2. Hole *A* is rough bored by a cutter *J* held in one end of a 3 7/16-in. boring bar at the first turret position. At the same time surfaces *C* and *E* are rough turned and surfaces *B* and *D* are rough faced by cutter *K* held in the square turret. Surface *A* is then finish bored by cutter *L* held in the opposite end of the 3 7/16-in. boring bar at the fourth turret position. At the same time surfaces *C* and *E* are finish turned and surfaces *B* and *D* are finish faced by cutter *M* in the square turret. This completes the operations to be performed in the first turret chucking. All cutters used are of stellite and the time required is 13 minutes.

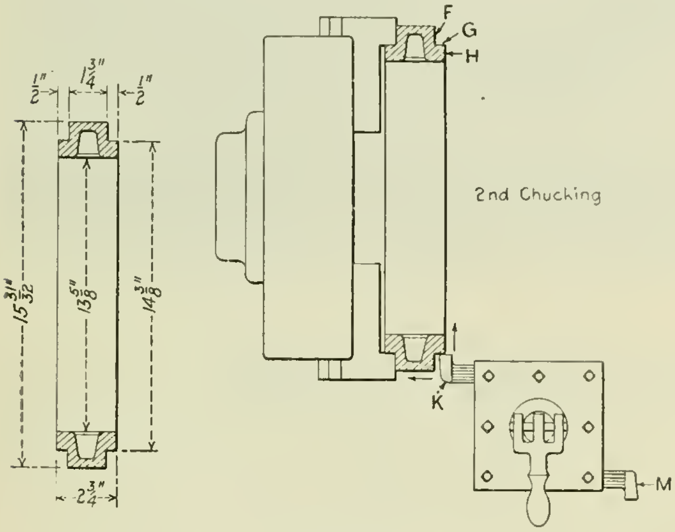


Fig. 3—Details of Bull Ring and Tooling Set Up for Second Operation

In the second chucking the work is held securely in soft jaws cut out to conform with the work as shown in Fig. 3 and the operations consist of finishing surfaces *F*, *G* and *H*. Surfaces *F* and *G* are rough faced and surface *H* is rough turned by cutter *K* held in the square turret. Surface *H* is finish turned and surfaces *F* and *G* are finish faced by cutter *M* held in the square turret. The work is removed from the chuck, all operations being completed. The time taken in the second chucking is 6 minutes, making a total time of 19 minutes required for machining the piston valve bull ring.

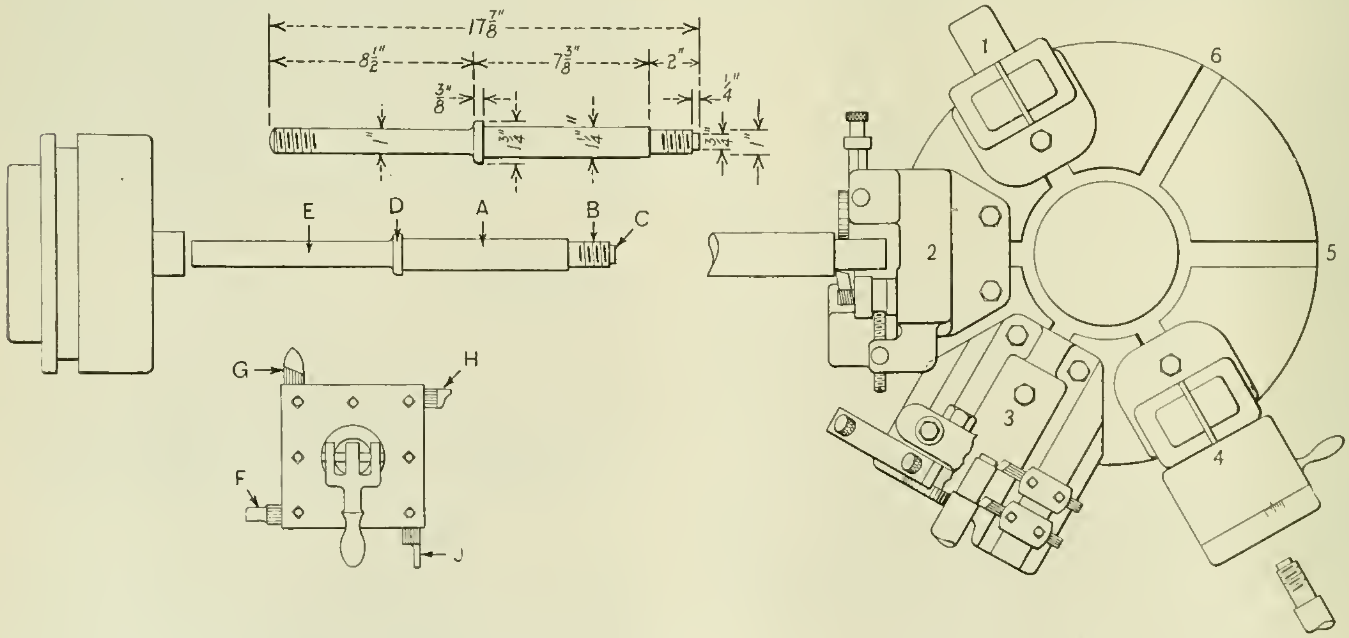


Fig. 5—Tooling of Universal Turret Lathe for First Operation on Emergency Valve Stem

Exhaust Pipe Packing Ring

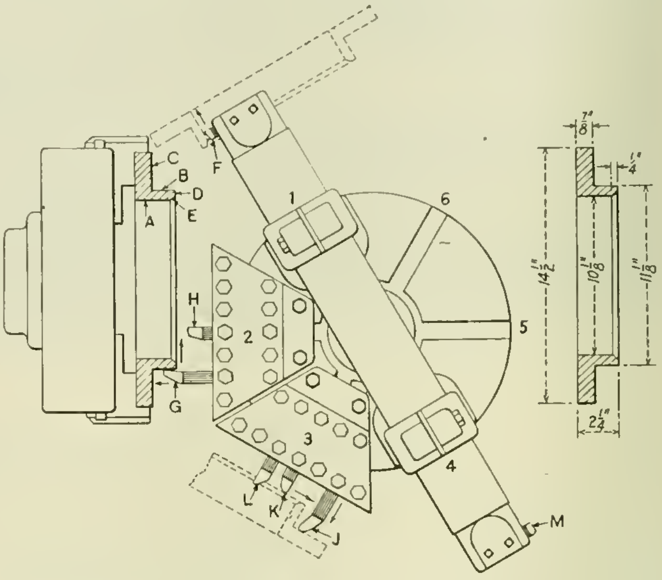


Fig. 4—Tooling of Combination Flat Turret Lathe for Machining Packing Ring

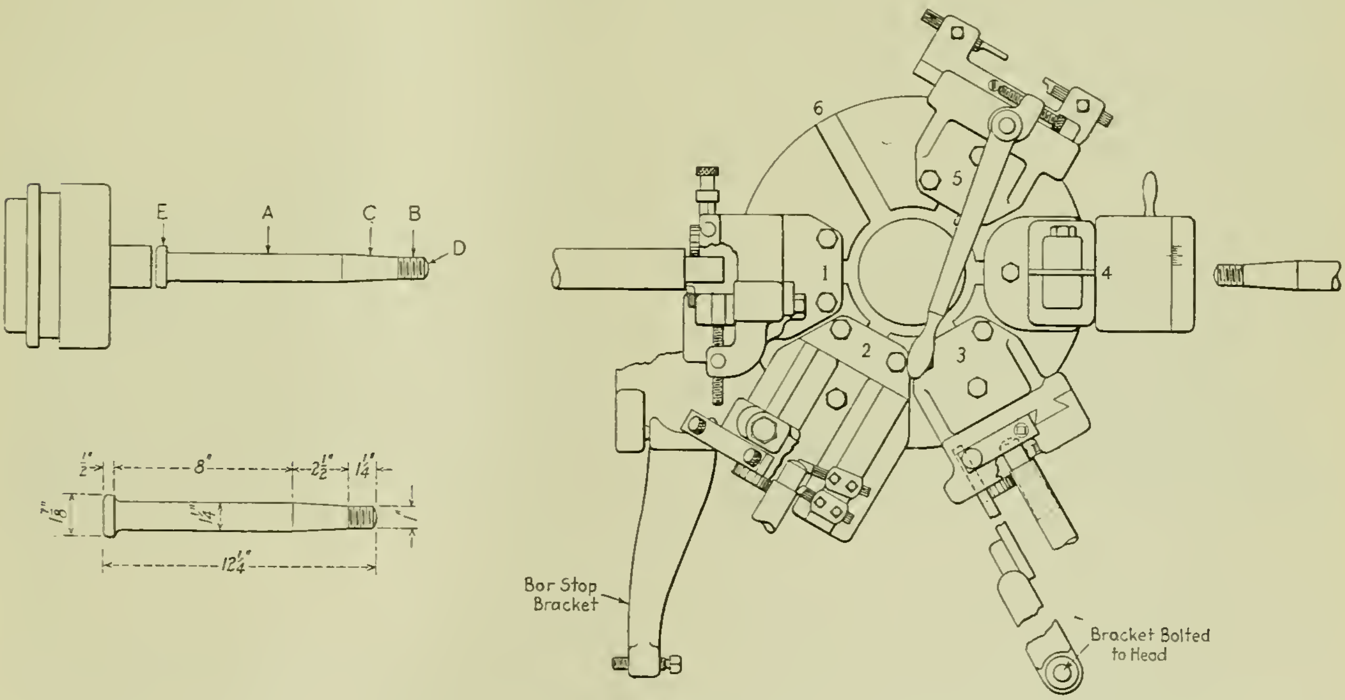
A packing ring for a low pressure exhaust pipe and slip joint machined on a 2¼ in. by 26 in. combination flat turret lathe with a cross sliding turret is shown in Fig. 4. The work is finished in one chucking and the operations consist of finishing surfaces *A*, *B*, *C*, *D* and *E*. A three-jaw chuck is used for holding the work on the flange diameter and the operations are performed in the following manner: (1) Hole *A* is rough bored by cutter *F* held in one end of a 3 7/16-in. boring bar at the first turret position. (2) Surfaces *C* and *D* are rough faced by cutters *G* and *H* and surface *B* is rough turned by cutter *G*, both cutters being held in a tool plate or multiple tool holder at the second turret position. (3) Surface *B* is finish turned by cutter *J*; surfaces *C* and *D* are finish faced by cutters *J* and *K*; and surface *E* is formed by cutter *L*, all cutters being held in a tool plate at the third turret position. (4) Hole *A* is finish bored by cutter *M* held in the opposite end of the 3 7/16-in. boring bar at the fourth turret position. The time required to finish the work in the foregoing sequence is 12 minutes.

Emergency Valve Stem

Machining an emergency valve stem from a steel bar on a universal flat turret lathe is illustrated in Fig. 5. The following is the sequence of operations: (1) The stock is fed up to the bar stop held in the first turret position. (2) Surface *A* is turned by a cutter held in a universal turner at the second turret position. At the same time, cutter *F* held in the square turret is fed into the work preparatory to turning surface *E*, after which this surface is turned by cutter *G*, also held in the square turret. (3) Surfaces *B* and *C* are turned by cutters held in a multiple cutter roller rest turner at the third turret position. At the same time the corner of surface *D* is rounded by cutter *H* held in the square turret. (4) Surface *B* is threaded by a screw cutting die head at the fourth turret position. (5) The work is cut off by cutter *J* held in the square turret. The time required to finish the work in the foregoing sequence is 8 minutes. It requires two chuckings to finish work all over, the second chucking consisting of rounding the end and threading surface *E*.

Reducing Valve Stem

A reducing valve stem, as shown in Fig. 6, can be finished complete in one chucking from a steel bar on a 2¼ in. by 26 in. combination flat turret lathe equipped for bar work. (1) The stock is fed against the bar stop bracket. (2) Surface *A* is turned by cutter held in a universal turner at the first turret position. (3) Surface *B* is turned and end *D* is rounded by cutters held in a multiple cutter roller rest turner at the second turret position. (4) Surface *C* is taper turned by a cutter held in a taper turner at the third turret position. The taper turner is aided by a taper bar made to conform with the taper desired. The bar is held on a bracket which in turn is bolted to the head stock. (5) Surface *B* is threaded by a screw cutting die head held at the fourth turret position. (6) The corner of surface *E* is rounded and the work is cut off by cutters held in a slide tool at the fifth turret position. The time required to finish complete is 11 minutes.



6—Stem for Reducing Valve Machined from Steel Bar on Combination Flat Turret Lathe

Prosser Flue Expander

Machining a prosser flue expander from a steel bar can be accomplished in one chucking on a 2¼ in. by 11 in. hand screw machine in the following sequence of operations: (1) The stock is fed up to the bar stop held in the first turret position. (2) Surface *A* is turned by a cutter held in a universal turner bolted to the turret face at the second turret position as shown in Fig 7. (3) Hole *C* is drilled by a drill held at the third turret position. (4) Hole *B* is drilled by drill held in fourth turret position. (5) Contour *D* and groove *E* are formed by cutters held in a form block bolted on the front of the cut off slide. (6) Hole *B* is taper reamed by a reamer held at the fifth turret position. (7) Hole *C* is taper reamed by a reamer held at the sixth turret position. (8) The work is cut off by a cut-off tool held in an open side tool post bolted on the rear of the cut-off slide. All operations are completed in 7 minutes.

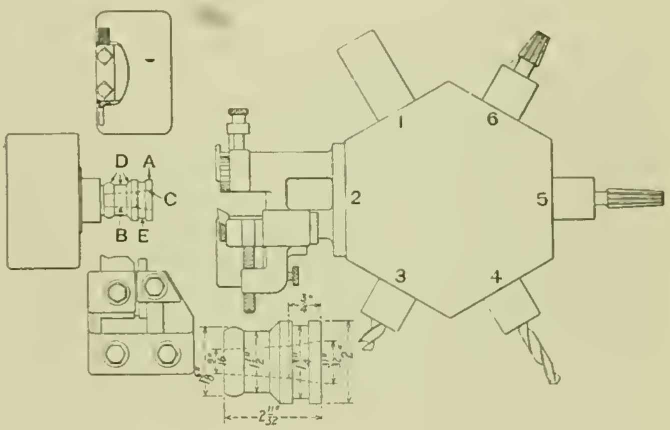


Fig. 7—Tooling of Hand Screw Machine for Making Prosser Flue Expander

The Reason Why Some Fusion Welds Fail*

Hardening Effect of Welding Heat Graphically Demonstrated and the Effect of Annealing Shown

BY T. D. SEDWICK

Engineer of Tests, Chicago, Rock Island & Pacific, Chicago

IN case of poor results from fusion welding shown either by laboratory tests or actual service, the inclination is to attribute such results to the material used, the method of making the weld, a poor operator, or the contributing effect of all three of these factors.

But there are other points that enter into the final results, and two of the important ones are as follows:

First—Was the metal in the casting or forging in such a physical condition that it was fit to be welded and afterwards give good service; did the metal originally fail on account of the presence of segregation of the various chemical elements; did it contain blowholes, porosity, or were there thermal stresses left from the original forging or casting operations; had the previous service fatigued the metal to the extent that it was inherently weak?

Second—Was the original metal adjacent to the weld deleteriously affected by the welding operation?

Some take the first mentioned factors into consideration, but I do not believe that very many, particularly the shopmen, give much thought to any action which may take place on the original metal. Tests and observations made on failed material and special test specimens have shown that welds fail although good conditions prevail in all other respects.

Investigation on various welds has shown that in the majority of the cases, especially in certain classes of material, the welding heat or the process of preheating has affected the metal in the sections being welded, causing a transformation of the physical structure of the steel, and in case of localized high temperatures the main body of the material absorbs the heat so fast that there results a quenching action on the heated metal. In the majority of instances the extreme hardening action will be localized near the surface immediately adjacent to the added metal. In some cases of preheating it has been shown that the high temperature causes a change in the physical structure of the metal, and while it is not usually so localized as in the case of the action of the welding heat alone, thermal stresses are set up in addition to those created by the heat of the welding process. These conditions have been found in material of thick sections where the heat would not be readily absorbed throughout the section and where the chemical content, especially the carbon, was such that it rendered the metal readily susceptible to structural changes, resulting in a hardened condition.

To illustrate some cases of this kind photographs have been secured showing several special tests and also some examples of failed material. A great many of these tests were made to demonstrate to the shopmen, that in the majority of the cases proper annealing should be done after the weld has been completed and that a thorough annealing would improve the physical condition of the metal, thereby causing it to render better service; this thorough annealing to be made by placing the metal in a furnace and giving it a soaking heat and then cooling it so that the whole mass could adjust itself to a uniform condition throughout.

The idea of causing a self or automatic annealing to take place by preheating is going at the proposition backwards and trusting to luck that we have not done more damage than good. It is necessary at times to preheat to take care of the shrinkage strains which might be set up in certain sections during the cooling after welding. What I am advocating is that after this has been done, we follow out a thorough annealing program. In this way any strain or hardened condition that has been set up by preheating, or by the welding heat, will be eliminated and we will then have a product the service of which will depend mainly on the quality of the material in the weld, and the perfection of the weld.

There are certain zones in any torch flame that are of a higher temperature than others, and as it too often happens that a sufficient length of time is not taken in preheating to permit a soaking heat, more or less locally heated areas are produced that multiply the thermal stresses not eliminated during the subsequent period of cooling.

In the majority of the shops, especially the larger shops, where special annealing furnaces have not been installed there are always some furnaces of sufficient size in which at least the smaller castings and forgings could be annealed and this annealing could be done at a comparatively low cost. At the close of the day, as space is being left unoccupied by the regular work of the shops, the welded material could be placed in the furnace and be annealed over night without any material increase in the cost of fuel. This plan would not check production of the regular work.

Too little attention is given to annealing in general even in cases where no welding is done. In reclamation plants where old material is re-worked, a worn out or failed forging will be reforged. When originally forged thermal stresses may have been set up in this material and not removed, or the material may have been overheated or even burnt. Later, during its actual service, fatigue stresses and unsatisfactory physical structure may have been produced. On reforging, further stresses may be set up and then without annealing to refine the grain and remove these stresses the forging will be returned to service. While it may give some service, if we had gone a little further and treated it properly, the extended service in my opinion would have been sufficiently great to more than justify any extra trouble or expense involved in a final annealing after forging. The same thought applies to welding of failed material.

There are a great many misconceptions of the process of annealing and a great many shopmen fail to observe the rule that it requires time for a piece of steel to adjust itself to the annealing temperature and be uniformly heated throughout. For instance, on one particular forging which the workman was instructed to anneal thoroughly he advised that he was doing so. But later it was found that he was simply sticking the forging into a blacksmith fire so that the welded area was buried in the fire. Under such conditions, while the extremely localized, highly affected areas will be removed, minor stresses will be set up back along the forging. To do the job right the forging as a whole should have been subjected to the annealing heat.

With such methods it is hardly fair to expect 100 per cent service out of material to which we have added or in which we have produced unsatisfactory conditions rather than reduced them. I am not looking at this matter from a strictly theoretical standpoint; the tests and the various failed material which have come to our attention justify these remarks. In a great many cases the only reason that a new forging may give good service is because the designer has allowed

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*From a paper read before the American Welding Society, Chicago Section, December 22, 1920.

for such a great factor of safety that the shopmen can do almost anything with the material and there will still be some service left. Assuming that a designer had originally made provisions for a factor of 10 and later the section was broken and welded, this weld in reality may have a factor of five. The designer attempts to take into consideration not only the ordinary service requirements but abnormal requirements that the material might need in case of emergency. If we have reduced this factor 50 per cent, the material might be able to go along in ordinary service with safety but for the emergency cases we may have eliminated the safety margin entirely. Sometime during the life of the material, it is going to run into extreme conditions. Then, if we have not taken the proper precautions, it will fail. Even where the welder has increased the cross-sectional area the failure can be traced to some of the conditions mentioned above.

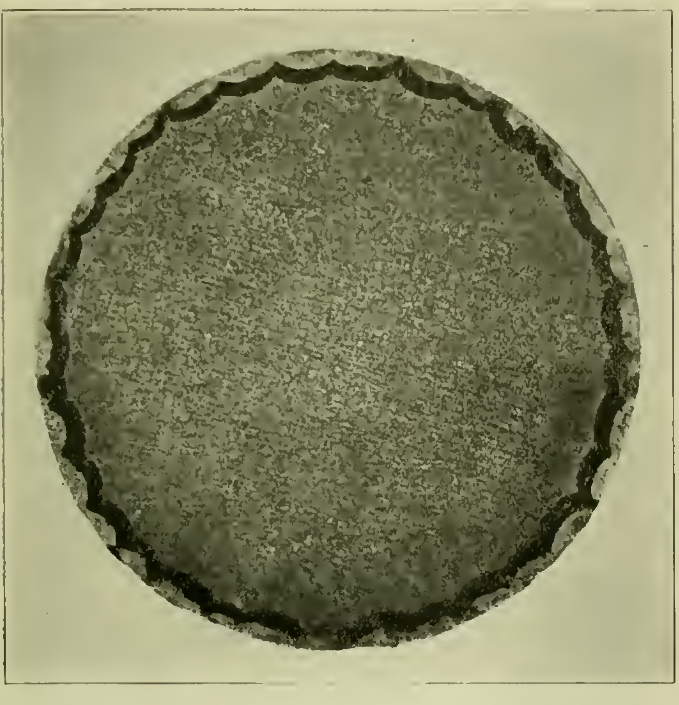
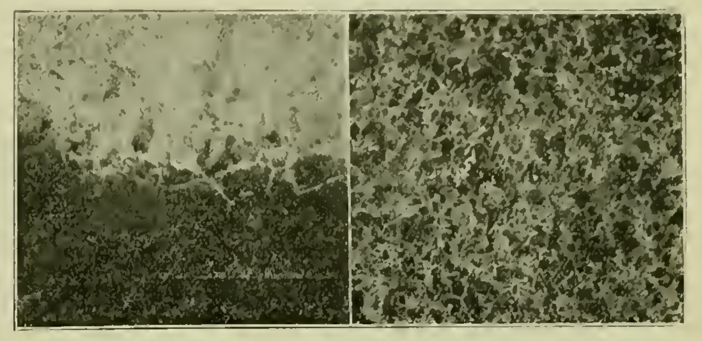


Fig. 1—Etched Cross Section of a Failed Piston Rod; the Crosshead Fit Had Been Built Up by Electric Welding

The photographs were taken in connection with some of the tests already mentioned, to illustrate the zones affected by the heat and the hardening effect of the welding operations. The method of bringing out visibly these hardened areas or structural differences without magnification involves the same procedure that can be used in checking the extent of the hardened or tempered areas in tools, such as chisels, hatchets, etc., and is comparatively simple. The surfaces are given a rough polish and dipped in nitric acid of specific gravity 1.13, or where this is not practicable the acid may be poured over the steel.

The hardened areas referred to, in a great majority of steels will correspond to the hardness that would have been produced had the steel been heated and quenched. In some of the tests illustrated strips were taken from the specimens so as to embody metal from the extremely hardened zones only, and then from adjoining positions progressing successively into the unaffected metal. It was found that in the zones where the hardened condition was highly localized these strips would not bend over 15 deg. before breaking or snapping off, but after annealing they could be bent flat on themselves, the same as the original metal.

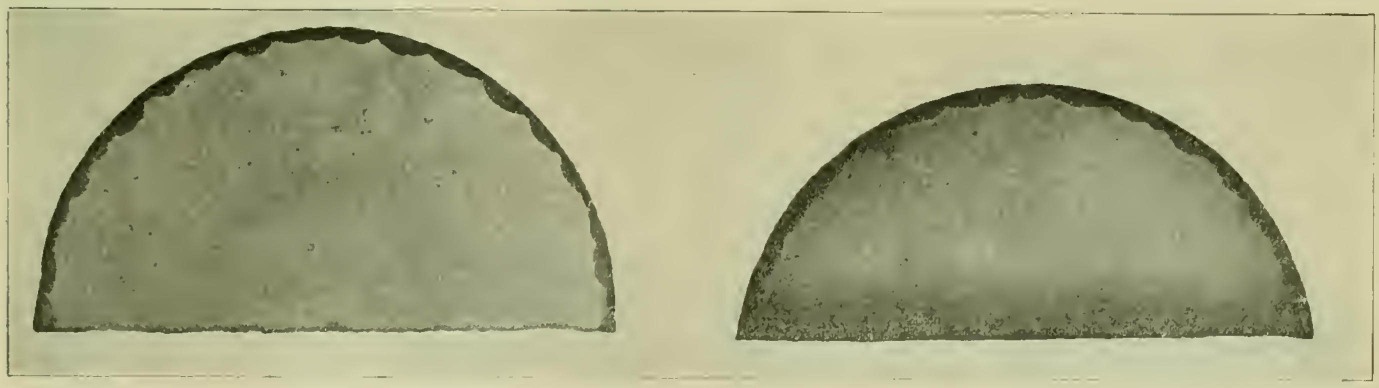


(a) (b)

Fig. 3—Microphotographs of the Metal in the Piston Rod Before Annealing; (a) the Added Metal and the Heat Affected Area; (b) Normal Structure at Center of the Rod

A failed piston rod on which the cross head fit had been built up by the electric welding process is shown in Fig. 1. The photograph shows the added metal on the outer area around the circumference and between this and the interior metal in the rod is a scallop-shaped area affected by the welding heat. This represents the condition of the metal in the rod at the time of the failure. The average scleroscope hardness of the added metal was 49, of the heat affected area 80, and of the metal in the rod proper 50.

The face of the same cut opposite to Fig 1 was cut in two and both pieces annealed, one-half being allowed to cool in the furnace and the other half in the air. It will be noted in Fig. 2 that the hardened area between the added metal and the parent metal has been eliminated in both cases.



(a) (b)

Fig. 2—Two Halves of the Face Opposite to That Shown in Fig. 1 After Annealing; (a) Cooled in the Furnace; (b) Cooled in the Air

The scleroscope hardness of the added metal in the piece cooled in the furnace was 38 and of the metal in the rod, 55. The scleroscope hardness of the added metal in the piece cooled in the air was 38 and of the metal in the rod, 57.

The fact that the added metal in these two photographs is shown in black should not cause it to be confused with the darkened area on Fig. 1 as in the latter two cases this was a matter of etching to differentiate between the added metal and the metal in the rod proper.

Fig. 3 shows microphotographs of the metal in the rod before annealing; *a* shows the added metal and the heat affected area in the rod, *b* the normal structure in the center of the rod, all at a magnification of 100 diameters. Fig. 4*a* and *b* are the microphotographs (100 diameters) of the two annealed pieces shown in Fig. 2. Both were annealed for three hours at 1,500 deg., F., after which *a* was cooled in the furnace and *b* in the air.

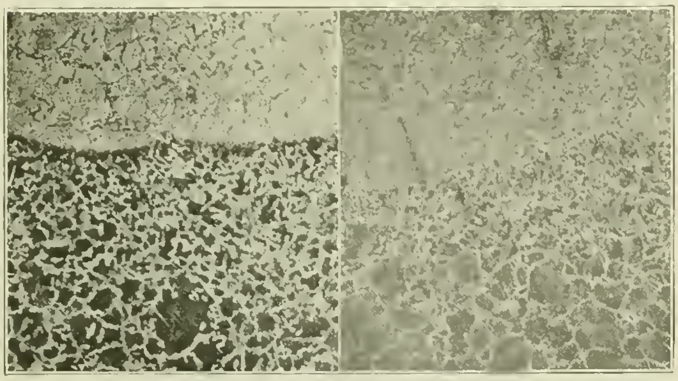

(a) (b)

Fig. 4—Microphotographs of the Two Pieces Shown in Fig. 2, After Annealing; (a) Cooled in the Furnace; (b) Cooled in the Air

Both show the added metal and the structure in the rod proper, the heat affected area having been eliminated by the annealing process. There is less segregation of the ferrite around the grain boundaries in the piece cooled in the air than in the one cooled in the furnace.

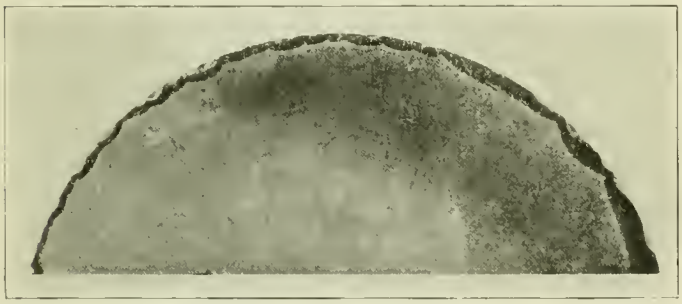


Fig. 5—Example of the Effect of Erratic Action by the Operator on the Uniformity of Heat Penetration

As a further illustration of the variation of the hardened zone, Fig. 5 is an etched cross-section of another piston rod on which the cross head fit had been built up, the rod originally being heat treated Nichrome steel. Attention is called to the variations in the area of this hardened zone in the parent metal. On comparison with the first rod shown, an unusually uniform movement and metal application by the welder is evident. It has occurred to me that an etching method similar to this might be adaptable for grading or examining welders as to their proficiency as well as for giving some indication as to the condition under which they were working.

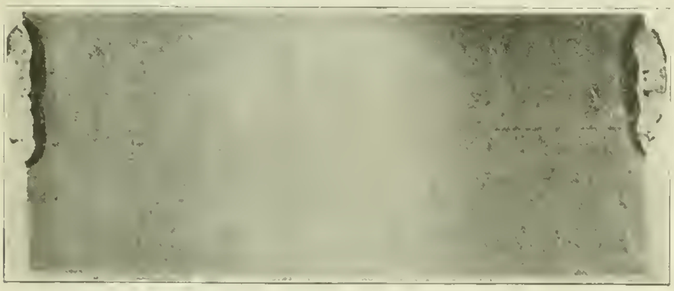


Fig. 6—Hardening Effected by Adding Metal Without Preheating—Electric Arc

The next few etched sections were made in an investigation to determine if a system of preheating could be developed to eliminate the hardened zones or heat affected areas created either through the preheating or the welding heat.

Fig. 6 is a crank pin, on which no preheating of any kind was done. The scleroscope hardness on the added metal was 33, on the hardened zone 58, and on the rod proper 46. The metal was added with an electric arc. Fig. 7 shows the previous piece after annealing, the added metal showing a hardness number of 34, and the pin metal proper 45. Fig. 8 is a piece of crank pin steel to which the patch was made after preheating the parent metal with the arc, resulting in the hardness numbers of 35 in the added metal, 50 in the hardened zone, and 47 in the rod. The metal was added with the electric arc. After annealing, the hardened zones were removed; the hardness number in the added metal was 35 and in the rod 45.


Fig. 7—The Hardness Removed by Annealing


Fig. 8—Metal Added After Preheating with the Arc

Another piece of the pin was preheated in the blacksmith furnace and metal added by the electric process; in this case the hardness number in the added metal was 34, in the

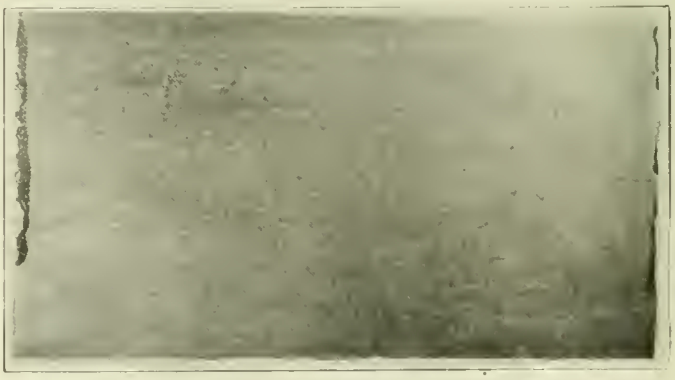


Fig. 9—Hardness Produced by Preheating with the Arc—No Metal Added

hardened zone of the pin 59, and in the body of the pin 46. After annealing, as in the previous instances, the hardened area was eliminated, resulting in a hardness number in the added metal of 34 and in the rod of 45.

Fig. 9 shows a pin which was preheated with the arc, but no metal added, resulting in a clearly defined hardened zone with a hardness number of 64, the body of the rod showing 44. After annealing of this piece the hardness was uniformly 45 out to the edge of the piece.

Metal was added around the section of a locomotive frame with the electric arc, without preheating. The metal was added in three layers with the idea that the succeeding layers might exert an annealing action on the affected area. The hardness number in the added metal was 34, in the affected area 57, and with the parent metal 47. After annealing this piece the affected zone was removed. The same frame member was preheated with the electric arc and metal again added in three layers, as in the former case, without showing any improvement in the hardening effect of the welding heat.

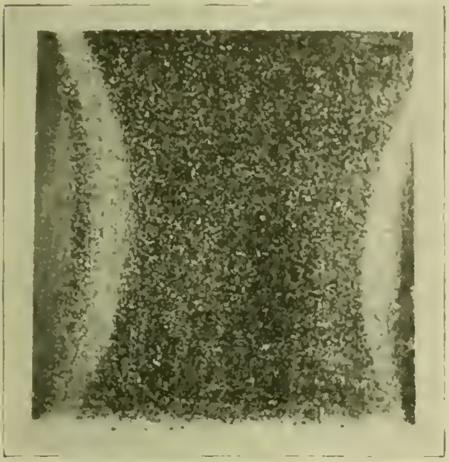


Fig. 10—Hardening Effect Produced by Preheating with Oxy-Acetylene Torch—No Metal Added

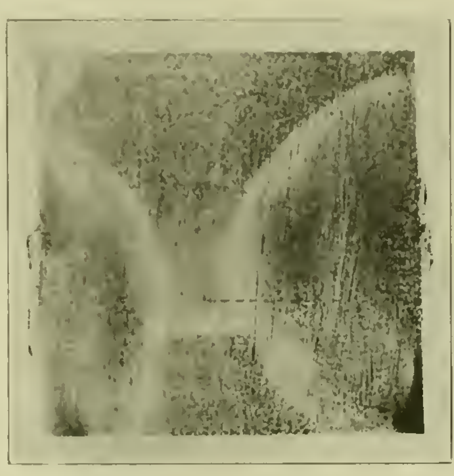


Fig. 11—Hardness Produced by Adding Metal with Oxy-Acetylene Torch After Preheating According to Regular Practice

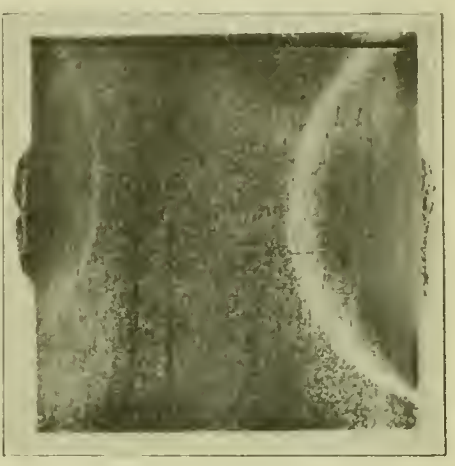


Fig. 12—Affected Zones Caused by Adding Metal with the Oxy-Acetylene Torch Without Preheating

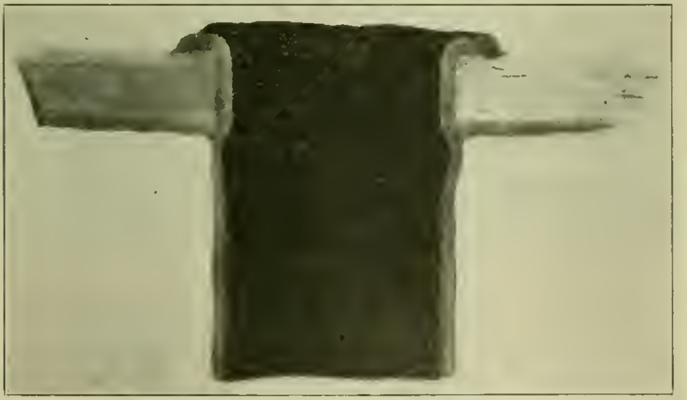


Fig. 13—Etched Section Through a Boiler Tube Welded to the Sheet; Metal of the Sheet Unaffected

Attention is called to the extension of the action of the arc ahead of the added metal, which may be observed in these photographs. It will be noted that the hardened zone extends about the same distance in front and back of the points where the welding operation starts and stops as it does beneath the weld. In a great many cases, in fact in the majority, it appears that a fracture will start by an initial check through the affected zone immediately back of or in front of the added metal, although there have been cases that unquestionably were a detail fracture starting from the area underneath the added metal. Fig. 10 is a piston rod which was preheated with the oxy-acetylene torch, no metal being added. The heat affected area is shown by the shaded zones, with a maximum hardness in the affected zones of 53, whereas the normal hardness in the rod was 44. After annealing, this piston rod showed a normal hardness of 45 throughout the rod section.

In the case shown in Fig. 11 the piston rod was preheated according to the regular practice and metal added by the oxy-acetylene process, producing the affected zones shown. The hardness of the added metal in this case was 32, in the affected zones 53, and in the rod proper 44. On annealing this piece the affected zones were removed; the added metal then showed a hardness of 34 and the rod 44. Fig. 12 shows the same affected zones when the metal was added by the oxy-acetylene process without preheating. The added metal shows a hardness of 32, the affected zones 53, and the body of the rod 42. On annealing, the affected areas were eliminated, resulting in a hardness number in the added metal of 35 and in the rod of 45.

A worn tire flange, with an original scleroscope hardness over the section averaging 49.2, was built up by electric welding. Before annealing the added metal had a hardness of 18, the hardened area of the original metal 67 and the body of the flange 48. After annealing, the hardness of the added metal was 20, that of the affected area 46 and the body of the tire 48.


Fig. 14—Example of Metal Too Poor to Weld

The average of several transverse tests on pieces of rail in which bolt holes were drilled, showed an average depreciation of the transverse strength of about 25 per cent as compared with the solid section. Where these holes were cut with the acetylene flame, this depreciation was 38 per cent.

The photograph, Fig. 13, of the boiler tube welded in the plate and then etched, does not develop the highly affected zones shown in the previous views. In this particular case the hardness number of the plate was 45, in the tube 50, and in the added metal 45. Even if the welding heat did cause unsatisfactory conditions along the lines in question, the service conditions would in themselves constitute more or less of an annealing process.

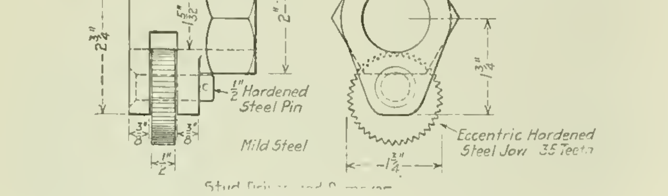
Fig. 14 is a piece of a member of a truck side frame which had been welded with the acetylene flame. It shows an unusually large area affected by the preheating and welding heat, particularly the white zone about the center of the section, which showed a penetration through the entire section. The metal is excessively porous and this casting should, in my opinion, never have been welded unless it was possible to cut away this area entirely.

I do not want to leave the impression that all welds fail on account of the structural changes due to the heating, or that I am advocating not doing any welding at all, or that I am in favor of any one particular process of welding. All the various methods of welding have their proper fields, and a great deal of profitable work can be done with them. However, if the points mentioned are taken into consideration by the party laying out the welding work, our welds will show fewer failures.

Stay-bolt and Stud Driver and Remover

BY F. OSBOURNE

It is the practice in some railroad shops to square the ends of stay-bolts for the purpose of driving with a box wrench or chuck driven by an air motor. This means that stay-bolts have to be squared in a forging machine or by some other method. The use of the devices, illustrated, eliminates the need for squared ends, thus saving a considerable amount of time and labor. The stay-bolt driver will drive 1-in., 1 1/16-in. and 1⅛-in. stay-bolts. If a bolt does not fit properly, it can be taken out with this driver by moving the eccentric steel jaw to grip the bolt, then reversing the motor.



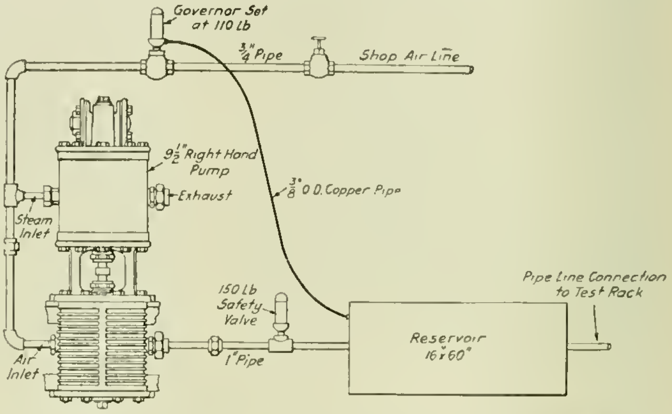
Tools for Driving Studs and Staybolts Without Squared Ends

Part of the stay-bolt driver is made hexagonal to fit a wrench and the other part is made a standard Morse taper to suit an air motor spindle. To use as a stud driver or remover, the device is made up without a Morse taper shank and has a hole bored through the driver. This will allow the eccentric jaw to grip any part of the stud and a wrench may be used. The stud driver shown will drive in or will remove old studs ¾ in., ⅞ in., 1 in. and 1⅛ in. in diameter.

High Pressure Pump for Air Test Rack

BY C. E. YOCUM

The piping arrangement shown in the sketch furnishes a simple means of increasing air line pressure to practically twice its normal value for testing feed valves, brake valves, etc. Air from the shop air line enters the pump at the steam inlet and also at the air inlet. If the pump is on either the upward or the downward stroke the shop line pressure is working on both the steam and air pistons. If the shop air line carries 90-lb. pressure this will give a maximum of 180 lb. per square inch. The governor may be used as shown and any desired pressure carried in the reservoir.



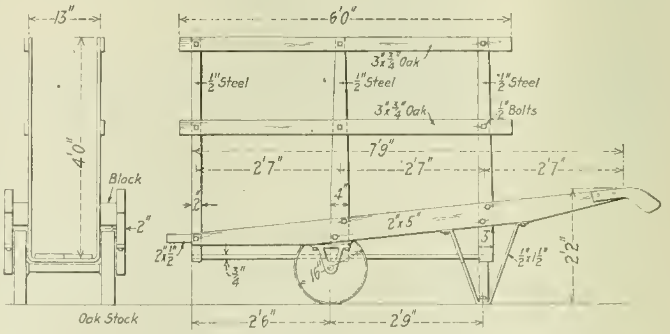
Pneumatically Operated Pump for Supplying High Pressure Air

Truck for Handling Jacket Iron

BY A. G. JOHNSON

Mechanical Engineer, Duluth & Iron Range, Two Harbors, Minn.

When the jacket is removed from a locomotive in the back shops, and is sent to the jacket shop for repairs or to be stored out of the way of other workmen, its removal and handling has always been a disagreeable, inconvenient job. This difficulty in handling can be overcome to a large extent by means of a special truck construction, as illustrated, at a small expense in each local shop. A shop truck is used as the foundation and high sides are provided, open at both ends. The sides consist of a frame-work of iron strips which may be riveted or welded at the joints. This truck will hold the entire jacket from one locomotive and enable it to be moved easily from place to place as desired.



Truck for Handling Jacket Iron

An English Locomotive Repair System*

An Outline of the Methods Followed by the Lancashire & Yorkshire in Putting Engines Through the Shop

BY COL. H. E. O'BRIEN

Assistant Mechanical Engineer, Lancashire & Yorkshire, Horwich, England

ENGINES are stopped at engine houses on the recommendation of either the boiler inspector or locomotive district superintendent, and the receipt of a waybill at the shops is a notification that repairs are required to such engine.

The waybill is filled in in duplicate, by the locomotive district superintendent and forwarded by him to the shops with a tubeplate diagram and a boiler stay chart.

The inspection department, when calling such engines into the shops, pay due regard, after conference with other departments concerned, to:

(a) Particular type of engine most urgently required by running department, varying with the season.

(b) Ability or convenience of the repair shops to deal with such repairs as may be required.

Light repairs are generally dealt with at once.

Waybills

Upon receipt of the waybill at the shops the duplicate is sent to the inspection department.

The waybill is a four-page sheet; on the front outside is stated the number and class of engine, the engine house to which it belongs, date stopped for repairs, experimental fittings (if any), flaws, date of last general repair, mileage since last repairs, mileage of tubes and crank axle, also additional remarks.

A Group of Automatics at the Horwich Shops of the Lancashire & Yorkshire

The first inside page provides a list of main items such as frames, pedestal jaws, wheels, axles, tires, axleboxes, cylinders, valves and valve gear, etc., for the engine and for the tender, with space for remarks.

The second inside page includes boiler fittings, boiler and tender tanks and coal bunkers.

The back, or fourth page, provides space for shop remarks upon details of repairs effected while the engine was in the shop, such as:

(*a*) Date left shop.
(*b*) Whether boiler had been out of frame.
(*c*) Cylinders out of frames.
(*d*) Experimental fittings, also boiler pressure, registered number of boiler, thickness of firebox side, type of valve and thickness of valves.

The bottom portion of this page also provides a space in which the engine house foreman can record the behavior of the engine in traffic during the first six days after receipt from the shops.

When the latter space is filled in, the waybill is returned for the shop superintendent's information and provides ground for exercising disciplinary methods in regard to the shops concerned.

Calling in to the Shops

The number of engines called in weekly depends upon the weekly output of repaired engines.

The number of engines of any one type standing at engine houses awaiting repairs is not allowed to exceed 10 per cent of that particular class.

A forecast of the engines likely to be sent into traffic during the following week is made, based on the above premises, and an equal number of engines are called in from the engine houses.

As far as possible, such engines are called in from particular engine houses as will permit the drivers and firemen of the outward-going engine bringing back with them one of the engines called in for that week, a considerable item in wages thus being saved.

Inspection Prior to Repair

Upon receipt of an engine at the shops for repairs an inspection is made while the engine is still in steam if possible.

This examination includes trial of injectors, whistle, steam sand and cylinder cock gear, cylinders and valves, ejector and boiler mountings in general, also tenders and tanks for leakage, etc.; any items missing are noted, and the brake cylinders and pipes are tested.

Where any of the items are found to be in good order the inspector marks the waybill to that effect.

At the end of the inspection the fire is dropped, tenders and bunkers are emptied of coal (this being transferred to engines coming out of the shops), and the engine is placed in a loop to await a vacancy on the stripping pit.

Stripping Pits

The method of dealing with engines on the stripping pits is as follows:

While fitters are uncoupling the motion and wheels, laborers are emptying the smokebox, taking grate bars out, brick arch down, and sweeping the firebox sides so that as soon as the ashpan is dropped the boiler examiner may examine the firebox.

During the stripping the chargehand stripper thoroughly inspects all parts and decides what bolt renewals are needed in cylinders, pedestals, etc., spring brackets to be cut off for bushing, and his report is added to the waybill sent to the erecting pits.

Heavy repairs (which alone are dealt with on the stripping pits) are, in accordance with the boiler inspector's report, subdivided into the following classes:

Class A.—Engines which have no large structural defects with the boiler and firebox in such condition that they can be repaired in the frames. All repair work for this class of repair should be dealt with as expeditiously as possible as it will be required back again to the engine in 18 days.

Class B.—Cases where the boiler has to be lifted and can be repaired in

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*Taken from a paper read before the Institution of Locomotive Engineers, England.

erecting shop upon the boiler pit or can be supplied with a spare boiler. This also applies to cylinders.

The work for this class of repair has to be returned to the engine within 21 days.

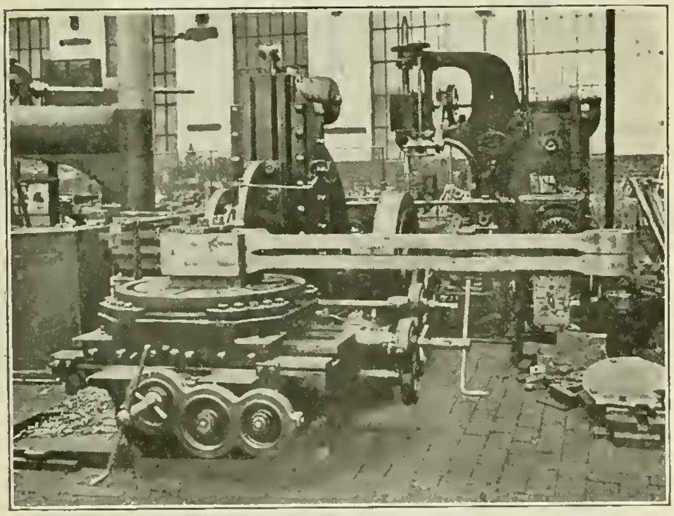
Class C.—All cases of heavy structural repairs such as cylinders, etc., or boilers needing boiler shop repairs. These engines are put outside of the shop when stripped until the main details are sufficiently advanced towards completion as to justify the engine being placed upon the erecting shop pit but no spare boiler is immediately available

Repairs of general details to such engines are not proceeded with in other shops until notice is given, which must be at least three weeks before engine is scheduled out.

The foreman stripper's report having been received in the office on the sixth day, with the order cards which have been made out showing all requirements in the way of new or repaired articles, and also the report from special examiners as to condition of motion, valves and faces, cylinders for renewal or boring, axleboxes, frames, etc., the actual ordering of the material upon the shop concerned is proceeded with.

These printed order cards are made out to the following benches, viz., piston bench, engine repair detail bench, motion bench, brasswork bench, cylinder bench, pick-up and spring bench. Copies are then made on tear-off pads, in triplicate, one set of which, with a copy of the engine house waybill, is sent to the gang foreman upon whose pit the engine is to be repaired; the second set is sent to the material progressman (a description of whose duties is given later), while the third set is sent to the department concerned with the repair or supply of the detail required.

The original order cards are forwarded to the finished work stores in the erecting shop. There each detail which can be supplied from the stock in hand is marked off.



Muir Puncher Slotter Slotting Main Rods

The cards are then forwarded to the holders of the third copy, and the finished work storekeepers' mark indicates to all concerned that such details will not be paid for.

Upon receipt of these cards shop orders are issued to the various gang foremen in the repair department, and as the work is completed the gang foreman enters opposite the article the date of supply; no work can be paid for other than this.

The cards are made to serve as a very useful check upon arrears in the details of any particular engine. Each gang foreman is provided with a box in which he keeps all his cards in three batches, each batch in numerical order; the front group represents material due out from his department in the next fortnight, the second group due out in three weeks, and the third due out in four weeks.

All detail work is expected out of the repair shops at least seven days before the engine is due out of the erecting shops; should, from any cause, an item be still unsupplied on the seventh day prior to the output date of engine, the card is taken out of the box and hung upon a special board provided, which is headed, "Work not supplied for engines due out in 7 days or less." The arrears are thus kept prominently before both the progressman and the foreman, and this has a tendency to keep arrears to a minimum.

In every department in the shops an output board, forecasting the output for the next four weeks, is posted, and this board has the engine numbers rearranged weekly as a result of conferences held in the chief inspector's department with the foremen concerned.

It is easy for the gang foreman, after each weekly alteration, to rearrange his cards accordingly.

In the event of any unforeseen development during the erection of an engine, such as the breaking of castings, or items having been overlooked on the stripping pit, application must be made to the material progressman, who issues a supplementary order card.

Engine Stripping Examination and Order Progress Card

Engine No........ Class of repair........

Chief Inspector or Principal Foreman to initial and certify when work was completed.

Operation	Date to be filled in by inspector or stripper	Number of days to complete after first day on stripping pit	Chief inspector or principal foreman. Initial	Date
In works....................				
On stripping pit..............				
Tubes examined				
Tubes dealt with..............				
Boiler examined				
Class of repair, A, B, and C...				
Wheels examined				
Motion examined.............				
Axleboxes examined..........				
Cylinders examined...........				
Springs examined.............				
Material delivered to shop....				
Material ordered.............				
On boiler pit................				
On erector's pit..				
Put outside, if a "C"........				
Promise of material..........				
Out of shop..................				
Wired away				

Fig. 1—Inspection and Progress Card

This card is of a different color than the ordinary card and has a column in which must be stated the reason for such late order, thus checking any laxity of supervision, reckless handling of material, or carelessness in delivery of repaired details.

Boiler Pit

In the case of an *A* class repair which has been placed on a special pit set aside for boiler repairs, all loose rivets in frames, platforms and splashers are renewed, and bunker sides and bottoms repaired; this work is expected to be completed in 12 days, when the engine is transferred to the erecting shop.

A *B* repair class is dealt with in the same way except that the boiler is in some cases lifted and repaired at the end of the boiler pit while the frames, bunkers, etc., are receiving attention.

If the boiler needs such heavy repairs as tubeplate renewals or ½-side patches, then it is sent to the boiler shop and one of a similar type is pressed forward on the boiler mounting pit so that it may be tubed and tested in time for its delivery to coincide with arrival of frames in the erecting shop.

Where possible, with engines needing *C* class repairs, the frames, etc., are repaired on the boiler pit before being sent outside in order to prevent delay in dealing with the engine when the frames are brought back into the shop.

The following table shows the time allowed to perform the different classes of repairs:

Pit	"A" Repair. Number of days allowed	"B" Repair. Number of days allowed	"C" Repair. Number of days allowed	
Stripping	6	6	6	
Boiler	12	14	14	Note.—"C" type only brought into shops again when work is ready.
Erecting	12	14	18	
	—	—	—	
Total days in shops..	30	34	38	

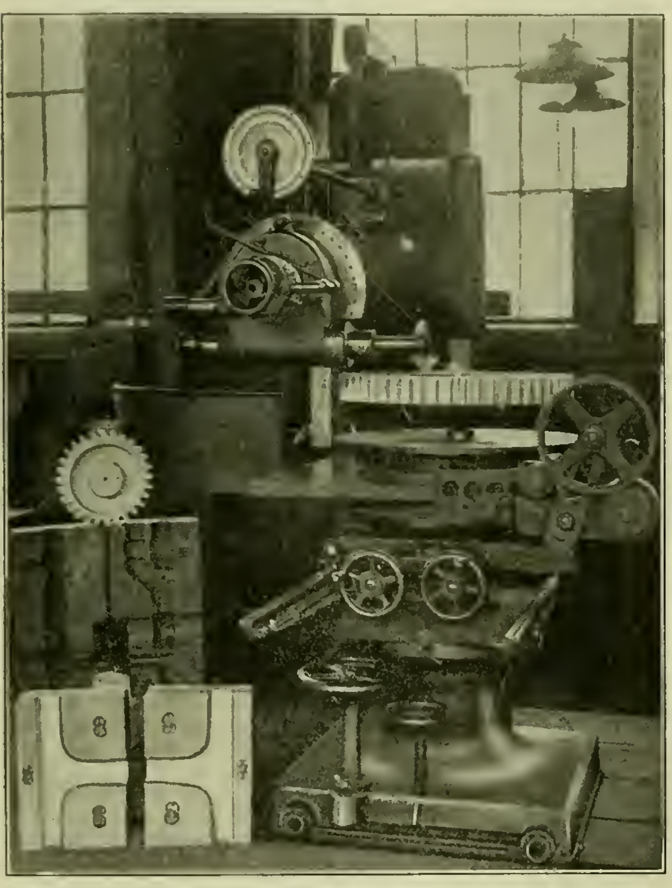
Progress Card

As a final summary of the system of engine stripping, examination and order progression a card system is used, the card being shown in Fig. 1.

These summary cards, described below, when completed, are returned to the chief inspector's office, and a monthly return of the average times taken for the various processes is shown.

Any card not completed within 10 working days of the date the engine goes on the stripping pit is sent to works manager's office for inspection.

The cards will be issued by the shop inspector, and when filled up, returned to his office so that the information may be summarized.



Universal Pattern Making Machine Working On a Spur Gear Pattern

In actual practice the summary for two separate months' working came out as follows:

	April	May
Engines sent away which have cards	59	66
Average days on stripping pit	6.19	6.46
Average days on boiler pit	7.85	6.65
Average days on erector's pit	27.96	26.06
Total time in shop	38.98	37.57
Finished off outside	7.33	6.95
Average days, tubes examined	3.33	3.92
Average days, tubes finished off	7.71	8.9
Average days, boiler examined	2.87	3.01
Average days, wheels examined	4.89	5.00
Average days, motion examined	3.97	4.52
Average days, axleboxes examined	6.09	8.12
Average days, cylinders examined	5.3	6.26
Material delivered to fitting shop	7.5	7.83
Material ordered from erecting shop	7.43	7.49

Duties of Erecting Shop Progressman and Progressing of Material

The delivery of material requiring repairs to the other shops is under the supervision of an erecting shop progressman, who is responsible for seeing that all engine details are stewed or cleaned and delivered to the other shops within 10 days from the receipt of the engine upon the stripping pit.

He is also responsible for the delivery of all repaired details to the erecting pit to schedule, having regard to the position of the engine on the output board.

By a daily perusal of the output board and the duplicated set of ordered material lists he is able to keep his finger on the pulse of the erecting shop, and to anticipate them as much as possible so as to keep items from figuring upon the arrears list (issued daily).

The arrears list, which is compiled by the progressman, contains all items not supplied to engines due out in the next seven days, and a copy is placed before each foreman at the daily conference, and later in the day is put before the manager together with the remarks made at the conference by the foremen concerned.

Twice daily, at specified hours, the progressman is interviewed by gang foremen who want such items as frame stays, pedestal blocks, etc., at an earlier date than the ordinary details; also by others who have material verging upon the arrears date and not yet to hand.

Finished Work Stores

In connection with the locomotive repair organization is a finished work store combined with a central order department.

The function of this store is to provide a daily and yearly record of new and repaired articles supplied to the erecting shop and the outdoor locomotive department. At the same time it insures that a maximum stock is not exceeded or a minimum stock depleted. At any time the stock of any item may be ascertained by the card index system in the store. By this means a system of central ordering is possible—which in its turn permits of articles being ordered in considerable quantities with consequent economy in production. It also provides a perfect and complete check on payment for machining and insures a ready supply for the erectors of the outdoor locomotive department of each article required.

Erecting Pits

The erecting shop crews consist of a gang foreman, five journeymen fitters, three apprentices, one hand driller, who acts also as laborer when not occupied with drilling. An additional laborer divides his time between two pits, sharing in any two-handed job as required, such as pinching or racking engine when valve-setting, replacing grate bars, etc.

Upon receipt of an engine, or frames from the boiler pit, the laborers at once scrape and clean the frames and pedestal blocks; the work of renewing loose pedestal and cylinder bolts is then commenced; where necessary the holes are opened out by drillers with portable electrically driven drills; fractured frames are chipped out to a feather edge and are afterwards oxy-acetylene or electrically welded, all studs upon cylinders and boiler (in the case of an *A* repair) are sounded and doubtful ones renewed, broken ones being drilled out.

Inequalities are removed from pedestal jaw cheeks, and the axleboxes (which, along with the brakework, etc., have been to the stewpot and are now delivered to the pit by the stripping pit gang) are tried up in the pedestal, adjusted and marked off for boring.

If a *B* class repair the boiler will now be to hand, and is at once placed in the frames and fastened down.

While the lagging nailing strips are being fitted on by a floating gang the erecting gang are; in the case of a changed boiler, setting the handrail brackets, jointing the steam teepipe and steam pipes, fitting the ashpan and grate bar brackets.

When this work is completed another floating gang of laborers place the asbestos mattressing in position. The sheathing is then applied, the cab is temporarily bolted, as is the smokebox, and the riveters take these in hand.

Meanwhile the guide bars are set and the motion work with the reversing gear are fitted by one fitter and apprentice, while another pair will have taken the wheels in hand and be mounting the axleboxes, hanging springs, etc., in readiness for wheeling; a fitter will also be engaged during the operations in placing all pipes, in the cab and below, in position.

After wheeling, the engine is placed upon a cradle and the valves are set by micrometer in accordance to figures supplied from the inspection department.

These figures are issued on duplicate slips, and based on vernier measurements taken of ports and valves.

Running Trial

This takes the form of about four hours' working of branch passenger traffic. Before trial the brake is tested by the brake inspector, who is responsible for the vacuum brakes and examination of all accessories.

The inspector keeps and maintains records of the life of all diaphragms and brake parts, and reports monthly upon their life.

It is possible to run four engines per day in this manner, but an average of about three per day is maintained, not including Saturdays. Saddle tank and dock engines, along with steam rail motors, however, are run in the shop yard and do not require to go on the branch line.

In all cases, at the conclusion of the run, the driver makes a report on the behavior of the engines, triplicate copies are then issued, one to the trial inspector, one to the foreman of the erecting department, and the third is sent to the gang foreman, under whose supervision the engine was repaired.

As soon as the engine is ready to go out, it is carefully examined by the trial inspector for possible defects or omitted repairs; the trial inspector takes the engine for a short run in the shop yard, after which, should everything be found correct, the engine is wired into traffic, unless it requires painting. The engine then goes to the weighbridge to have the weights adjusted and during this adjustment the trial driver's report enables the gang foreman to rectify any minor defects that may have revealed themselves on trial. The outdoor locomotive department are informed that the engine is ready for traffic unless it requires repainting.

Paint Shop

Engines are usually a month in the paint shop as all the old paint upon splashers, cab and sides, tanks and bunkers, needs removing with some detergent before repainting.

The covering will, in the majority of cases, have been sent to the stewpans while the engine was on the boiler or erecting pits and therefore is not in need of any further preparation.

Return Into Traffic

As soon as a repaired engine is wired into traffic the waybill is forwarded through the outdoor locomotive department to the district locomotive superintendent of the district to which it is allocated.

The waybill at this stage has upon it the whole of the repairs stated in detail, the condition of firebox sides, thickness of valves, etc., etc., and is accompanied by up-to-date stay and tube charts.

After the engine has been in traffic for six days the district locomotive superintendent fills in on the waybill repairs or adjustments which have been necessary during that period. The waybill is then returned to the shops and the defects are brought to the notice of the foremen for explanation.

Closing Triple Valve Piston Ring Grooves

An efficient device for slightly closing the packing ring grooves in triple valve main pistons is illustrated in Fig. 1 and shown in detail in Fig. 2. The principle of the device is simple, since it consists of delivering a heavy blow on the curved portion of the piston head by means of an air hammer, thus closing the ring groove not only at the outer portion, but the whole depth. This method is used to reclaim pistons with badly worn grooves and thus reduce the number of new ones to be bought.

The device consists of a steel shell turned and bored out to form an air cylinder as indicated. A removable anvil, *A* (Fig. 2) is supported on block *B*, which is drilled and slotted to receive the triple valve piston. Plunger *P* is normally held in its upper position by means of a coil spring and is operated by the piston shown. A packing leather with the customary expanding ring is used to make this piston tight in the cylinder. On opening the operating valve it is evident that a rush of air on top of the piston will cause its downward movement against the compression of the spring and will deliver a heavy blow at the desired point of the triple valve piston.

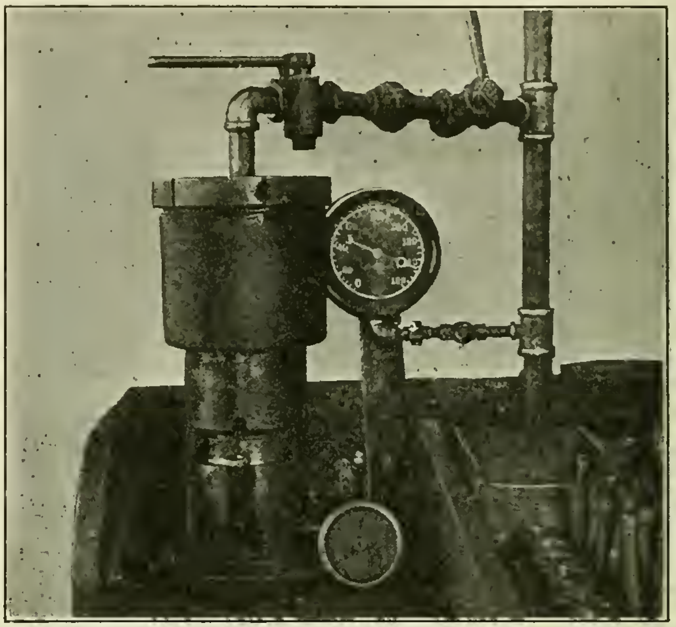


Fig. 1—Device for Slightly Closing Triple Valve Piston Packing Ring Grooves

The triple valve piston is absolutely centered on the anvil block by the holder and is sufficiently closed by one blow with 75 to 90 lb. air pressure per sq. in. After closing the grooves, the pistons are chucked in a small lathe and the grooves machined to the standard width, using a special tool holder. Standard cutting off tool blanks are used in this holder so that the only grinding required is on the end. Piston rings are fitted to the grooves after machining by lapping on fine emery cloth until they will just enter the groove under hand pressure.

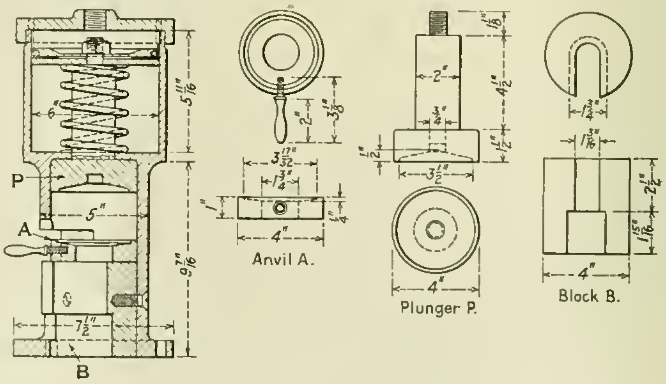


Fig. 2—Details of Groove Closing Device

A Short Cut in Squaring Locomotive Valves

Valves Are Squared by This Method Without Applying the Main Rods and Afterwards Removing Them

BY WILLIAM ULRICK
Foreman Valve Setter, Scranton Shops, Delaware, Lackawanna & Western

AT the present time when it is necessary to obtain maximum production in all locomotive repair shops, the following method of squaring either Baker or Walschaert valve gears without applying the main rods will be found a great time and labor saver. The process has been used for several months with good success, only an occasional readjustment of the valves being necessary, which is likely to happen with any method of valve setting.

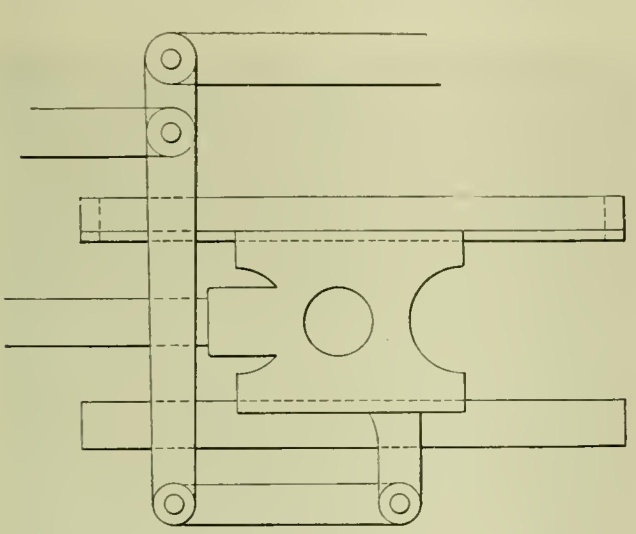


Fig. 1—Positions of Parts With Crosshead and Radius Bar on Center

In practically all railroad shops the practice is to apply main rods before setting the valves and afterwards it is necessary to remove them before applying the side rods. This is an unnecessary repetition of work and can be avoided by the following method. The first operation before setting either of the valve gears referred to is to apply the various parts of the motion work and see that all are in good working order without lost motion or undue friction.

Method of Procedure

After all parts of the motion work are in place, the port marks are taken as usual, using a tram to transcribe the marks to the valve stem. Dead center positions of the crank pin are scribed on the wheel center (right or left as the case may be), using the customary tram. Since the main rods are not up, a special light fish-tail tram has been devised to take their place simply while getting the dead centers. This tram consists of a brass plate cut in the form of a fish tail and bearing on the crank pin at two points. Attached to the brass plate is a light 1 in. by 4 in. wooden strip approximately equal to the main rod in length and having an adjustable scriber at the end. With the crank pin a little above the dead center a vertical line is scribed on the cross-head at a level with the wrist pin hole. The wheels are then rolled past the center until the scribing point on the tram comes back to the original mark. The two positions are marked on the wheel center in the usual manner and dividing the distance between them gives one dead center. The other dead center is obtained in a similar manner.

The main crosshead is now placed in the center of the stroke, determined from the travel marks, with the reverse lever also on center as shown in Fig. 1. If all motion work parts are the right length, properly adjusted, and the link block is at the link center, the center line of the combination lever will be vertical. If the combination lever does not stand vertical, it is due to a defect or combination of defects which will be explained later together with the remedies.

To check the position of the eccentric arm, the wheels are turned, catching either the front or back dead center and with one end of a tram at the center of the link foot, a line is scribed on the guide yoke or any other convenient stationary place. Then the other dead center is caught and the same tram used to scribe a similar line. If the two lines come in the same place, it is evident that the eccentric crank arm is properly located. If, however, the two lines come, for example, ½ in. apart, the eccentric crank arm is shifted on the main crank pin so that the tram mark will come halfway between the two lines. This setting will give the correct location of the eccentric crank arm but if trial shows that a slight error still exists, it will necessitate going through the operation twice.

The reverse lever is now thrown in full gear forward and the nearest center caught, rolling the wheels forward. The position of the valve is scribed on the valve stem, using the tram previously employed to scribe the port marks. The wheels are then rolled and the travel of the valve marked on the valve stem. With the reverse lever thrown to the full gear backward motion, the centers and travel marks are again obtained in the same way.

If the valves are properly set, all marks on the valve stem that were scribed by catching the dead centers, will come in the center of the port marks, because the lap and lead lever is stationary and the valve is not receiving any motion from the cross head. In other words, the effect of the lap and lead lever is eliminated.

The valve travel, as obtained by this method, is for all practical purposes correct since the extreme travel takes place when the engine is very nearly on the top or bottom quarter. This would bring the cross head practically to the center of the stroke, even if the main rod was applied. Port and travel marks when the valves are properly squared are shown in Fig. 2, although it is not necessary to have an equal amount of port opening, front and back, as long as there is the same amount of travel on both sides of the engine. For example, if the right side has 6 in. travel, the left side should also have 6 in. travel, which is obtained by shortening or lengthening the radius bar lifter or short reach rods, as in the ordinary method of valve setting. Fig. 2 is of rare occurrence in the Walschaert gear, as it is impossible in

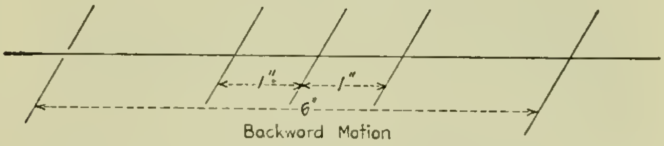


Fig. 2—Port and Travel Marks When Valves Are Square

some gears to get a square valve and the same amount of port opening on each end in full gear. In the Baker gear, it is a bad error as the maximum port opening nearly always will vary from ½ in. to ⅝ in., which cannot be overcome as the gear is at present designed.

Defects and Their Remedies

The positions of tram marks secured when the eccentric rod is ⅛ in. too short are shown in Fig. 3. It is evident that the valve must be moved ahead or to the left ⅛ in. in the forward and back ⅛ in. in the backward motion in order to make the valve square. As indicated in Fig. 3, due to the position of the radius rod, a change of ½ in. in the length of the eccentric rod would produce a movement of the valve of only ⅛ in., due to the ratio of 4 to 1. On account of the forward motion being direct and the backward motion indirect, the eccentric rod must be lengthened ½ in., which will bring both tram marks to the center.

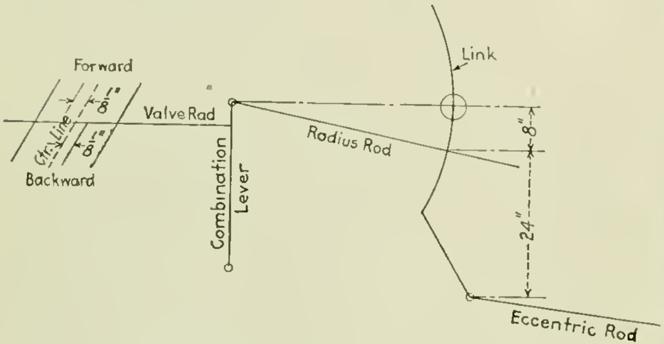


Fig. 3—Effect of Short Eccentric Rod

The positions of tram marks with a radius bar or valve rod ⅛ in. too long are shown at *A*, Fig. 4. It is evident that shortening the radius bar or valve rod ⅛ in. will correct this condition, but the question is, which shall be shortened? The radius bar should be maintained as nearly as possible the same length as the radius of the link, a condition which is easily checked as follows. With the link on center and a radius bar of the correct length, the reverse lever can be changed from full forward to full reverse gear without moving the valve. Alterations in the radius bar are made until this condition holds true. In the above problem, if the radius bar is checked and found to be the correct length, it is obvious that the valve rod must be shortened ⅛ in. or the valve adjusted on the rod, which amounts to the same thing.

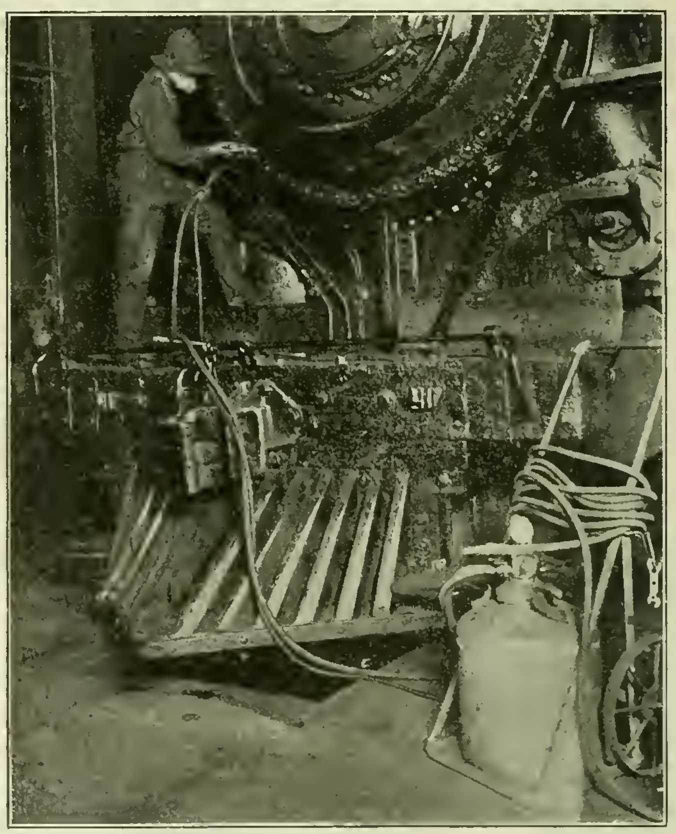
Fig. 4—Effects of Long Radius or Valve Rod and Short Eccentric Rod

The effect of a long valve rod and short eccentric rod are shown at *B*, Fig. 4. Shortening the radius bar or valve rod ⅛ in., will give the condition shown in Fig. 3, which can be corrected by lengthening the eccentric rod ½ in. When the front and back motion marks are all taken, it is advisable to throw the reverse lever nearly to the central position and turn the wheels one complete revolution, taking the complete travel marks. These will come equal distances either side of the port marks, according to the position of the reverse lever. If the lever is hooked up shorter, the distance will be larger; if thrown toward the corner, it will be less. If this is done in the forward motion or with the lever hooked up in the running position, any slight error due to lost motion or irregularity in the valve gear (especially in the Baker gear) will be overcome. If these measurements are not equal a slight adjustment on the valve, by shortening or lengthening, will overcome this error. The method of squaring valves described is not capable of the refinement of some other methods and does not give all of the events of the stroke. On the other hand, it reduces the time required for squaring valves by about three hours and saves the cost of labor for applying and removing the main rods. Several months' actual use of this method has failed to show that greater refinement was necessary.

Paint Spraying Locomotive Front Ends

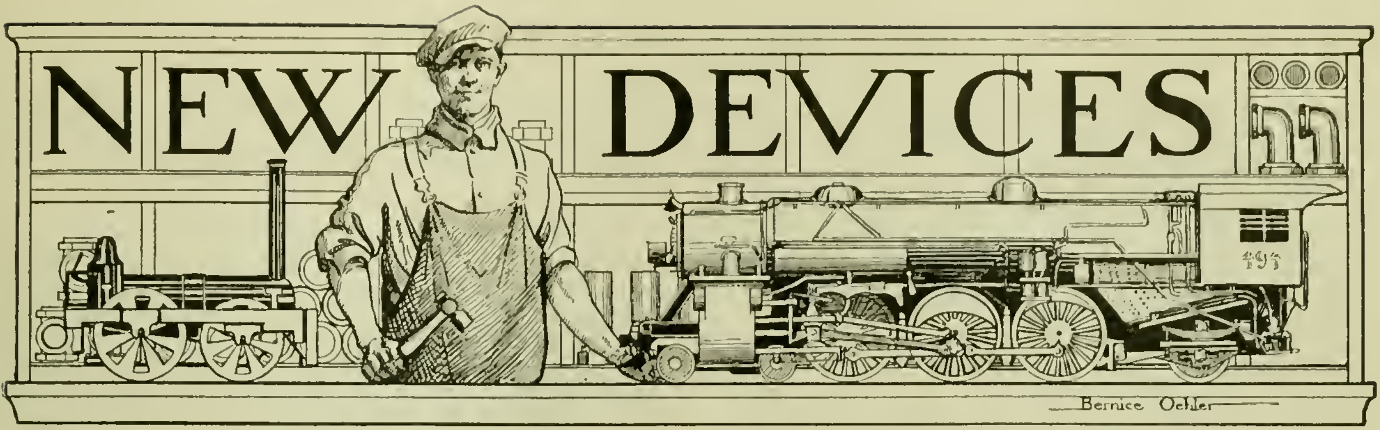
The proper maintenance of equipment requires frequent painting of locomotive front ends and this work consumes a large amount of time where it is done with a brush. To decrease the time required for the operation and permit keeping front ends in good condition, various forms of paint spraying equipment can be used to good avantage.

For greater convenience in moving about, the paint spraying equipment illustrated has been mounted on a two-wheel truck and can be moved readily from place to place by one man. Arriving at the engine to be painted, it is only a question of coupling the air hose, adjusting the respirator and starting to work. The job is finished in a short time and the outfit moved on to the next engine.



Easily Handled Paint Spraying Equipment

Trouble is Sometimes experienced by the lead sticking to the work. This can be avoided by dipping the article in a solution of cyanide of potassium and water—about one pound of powdered cyanide to one gallon of boiling water. This should be used cold and the article permitted to dry before placing in the lead bath. The pieces should be left in the lead only long enough to heat them through. The pieces can be quenched in oil, water or brine, as preferred.—From Houghton's "Steel and its Treatment."



Single Pedestal Swivel Type Car Seat

A CAR seat involving several important changes from the usual type of construction has been invented and patented recently by Frank Smolar, Dayton, Ohio, and will be placed on the market by the Dayton Car Seat & Manufacturing Company of the same city. One of the principal objects of the new invention is to provide a car seat with a back not normally inclined. The occupant inclines the back at will against springs in the arm rests to whatever position may be most comfortable and the springs return the back to its normal upright position when the seat is vacated. The inclined position of the back is indicated plainly by dotted lines in Fig. 1.

Fig. 1—Normal and Inclined Positions of Smolar Car Seat

The new car seat is light in weight, easy to install, and is not connected to the wainscoting. The latter feature eliminates drilling and tapping the wainscoting, and using the window sill as an arm rest. The seat may be easily and quickly assembled and dismembered for cleaning purposes without the use of tools. A greater height than usual is available for steam pipes and there is ample room for suit cases and traveling bags under the seat bottom. An especial effort has been made to secure simplicity of construction without complicated parts to break or get out of order; also a minimum weight consistent with strength and rigidity. The seat may be automatically locked when in either extreme position and is stated to reverse easily, no lubrication being required. The swiveling feature makes it necessary to provide only one foot rest.

A view of the Smolar car seat, disassembled, is shown in Fig. 2. *A* and *B* are the seat and back cushions respectively. The main seat support consists of a steel casting or pressed steel frame work supported upon and guided by the frusto-conical pedestal *D*. Each arm rest *E* is divided horizontally, the lower section having a deep longitudinal recess, containing the anchor piece, spring, slide piece *G* and guide. Tension of both arm rest springs through the connections shown holds the back cushion in its normal upright position. The top section *F* is provided to cover the recess and parts enclosed in the arm rest.

The foot rest *H* is secured by means of two hinges to the main seat frame. A dog is provided which engages the slot in the pedestal and holds the seat firmly in either of its extreme positions. A small spring holds the dog in engagement with the slot and foot pressure on a small pedal casting fastened to the foot rest releases the dog and allows the seat to be swiveled.

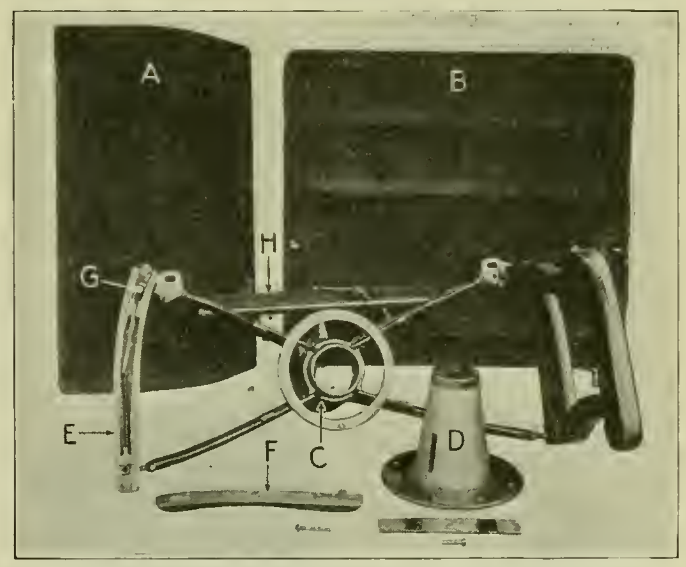
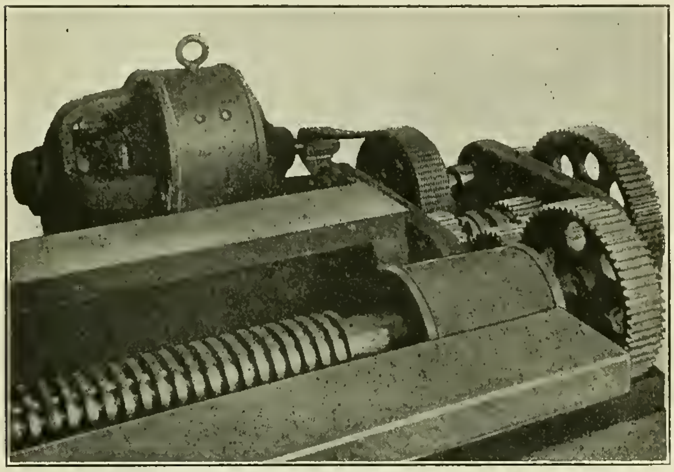


Fig. 2—View of Car Seat Parts Disassembled

Owing to the fact that the back does not need to be pulled over, cushions for the new car seat can be made to practically any desired height, width or shape to provide the greatest comfort for the passengers.

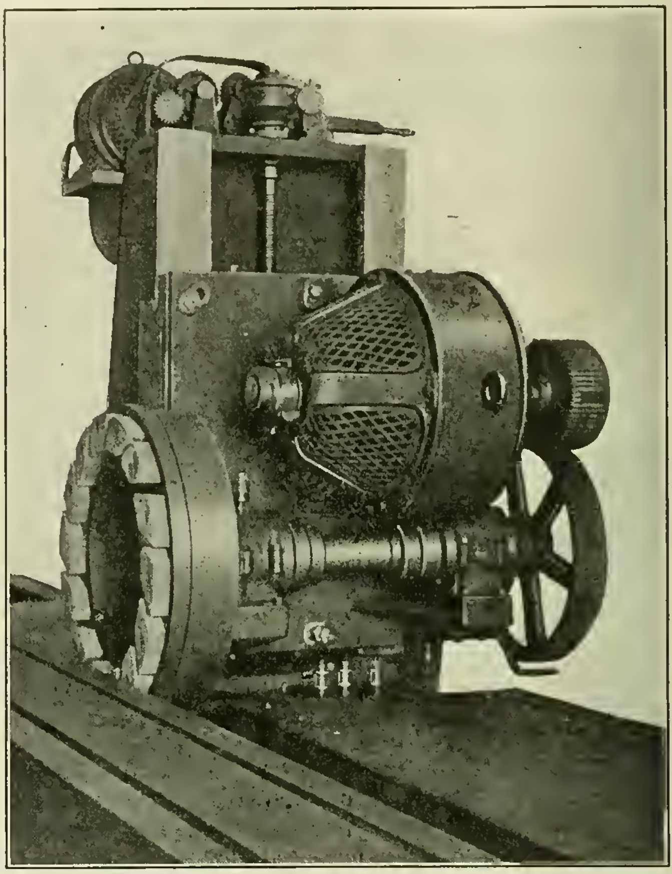
Heavy Duty Motor Driven Face Grinder

A MOTOR DRIVEN face grinding machine intended for heavy duty has been developed recently by the Bridgeport Safety Emery Wheel Company, Bridgeport, Conn. The new machine is arranged to be driven by an alternating current or direct current, 40-hp. motor, operating at a speed of 1150 r. p. m. For driving the lead screw and traveling head, a 7½-hp. motor running at the same speed is used. The grinding wheel is raised or lowered by a smaller 3½-hp. motor running at 850 r. p. m.



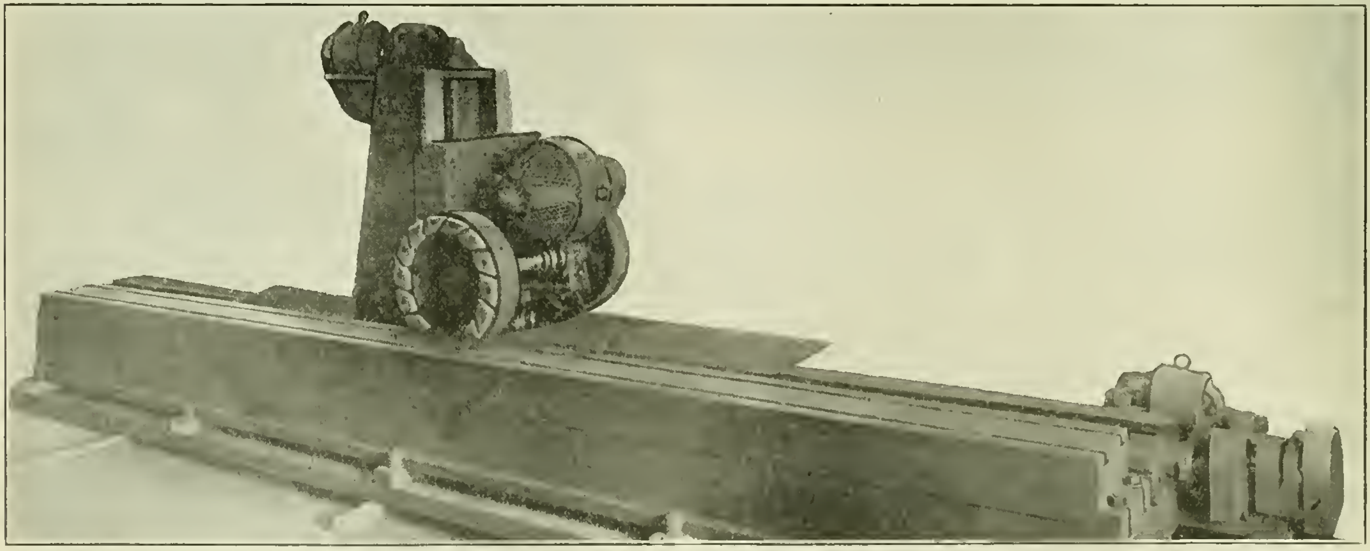
Mechanism Operating Lead Screw

The machine, designed to be set on mason work which forms a solid foundation, has a bed 30 ft. long for grinding work 24 ft. long. The bed has flat top rails, 6 in. wide, over which a short carriage is traversed, gibbed to take up for wear, with a heavy column securely mounted. The column has one upright face finished with wide, flat tracks and a gibbed carriage with a 2-in. elevating screw for vertical movement of the grinding wheel. On this carriage there are horizontal tracks with a carriage for feeding the wheel up to the work. Movement of the carriage is by means of a 1½-in. screw and a 14 in. hand wheel. On top of the horizontal carriage there is a turret pivoted at the center so as to grind the work square across or at an angle, with a clamping screw at each corner to hold the turret firmly where placed. The motor and grinding wheel spindle are bolted to the turret so that both move together when swiveled. The machine has a wide-faced fibre pinion meshing into a gear about twice its diameter on the back end of the grinding wheel spindle. This provides a back gear arrangement of about 2 to 1.



Wheel Drive and Elevating Mechanism

The wheel spindle runs in ball bearings with end thrust ball bearings each way, adjustable endwise for any wear. It is stated that machines have been run constantly for eight years on hard work, with bearings thus constructed, and have given the best of satisfaction. The grinding wheel is made up of 14 sectional blocks forming a wheel 32 in. in diameter, 8 in.



Heavy Duty Face Grinder With Traversing Column and Grinding Wheel deep, with a cutting rim 4 in. thick. An open space is provided between each section for material ground off to work into, as is common with metal-working tools. The motor on top of the upright column, designed to operate the grinding wheel head up or down through spur and worm gears, is back-geared down to a practical speed for the elevating screw. A shifting lever operates the gears to move the wheel head up or down as desired.

A suitable cast iron guard covers the gears on the motor and grinding wheel spindle. There is a 5 in. lead screw through the center of the entire length of the bed, connected at the left hand end to the 7½-hp., motor through a chain drive and a train of spur gears to get the right reduction of speed between the screw and the motor. There is in this train a toothed clutch operated by the shifting lever to revolve the lead screw in either direction to make an automatic traverse of the wheel. The lead screw runs in radial ball bearings at both ends and also has end thrust ball bearings on each side of the box at the right hand end of the lead screw, with adjustments for any slight wear. There are several supports under the lead screw, between the end bearings, to prevent the screw from sagging.

On the front of the column at the bottom is a stop that comes in contact with the shipping dogs for automatically reversing the traverse of the column. These dogs are on a shipping bar extending the full length of the bed, supported at about five points, and two shipping dogs between each bar support, pivoted so they can be thrown back quickly out of the way and only two of them used as required to cover the range of travel desired.

There is a work supporting bed the length of the machine, with a working face 18 in. wide, having two T slots the full length. The work is firmly bolted to this bed so the face to be ground comes in contact with the grinding wheel; if the work extends back from the table to any great extent, it should be supported by suitable horses. A full length supplementary table, 10 in. deep, is provided to go on the work table when small pieces or sheet stock is to be ground.

Tube Safe End With Square Shoulder

A NEW design of tube safe end, manufactured by the Coleman Boiler Appliance Company, Los Angeles, Cal., is provided with a square shoulder and a taper fit in the back tube sheet, the ends being beaded over as usual but not electric welded. The principal object of this new safe end is to hold the tube firmly against movement in either direction and eliminate leaks in the firebox, thus increasing the tube mileage and reducing engine failures due to leaky tubes. It is stated that the Coleman safe end is particularly effective in bad water districts and can be used successfully on oil burning locomotives. It has been tested over a period of 30 months on the Atchison, Topeka & Santa Fe with satisfactory results and is now being introduced on other prominent roads throughout the country.

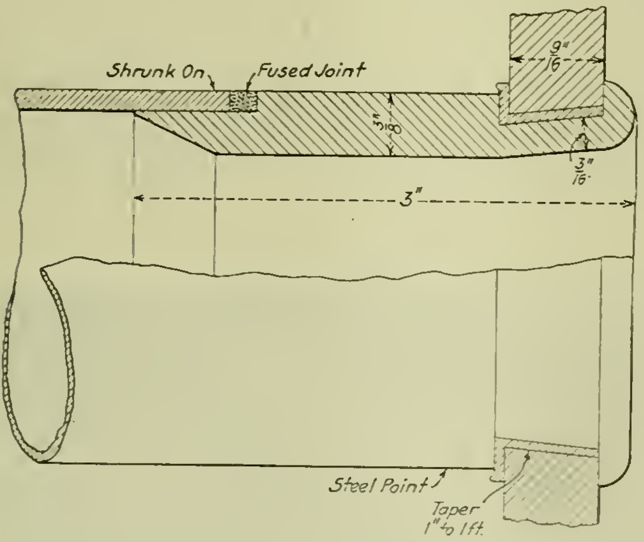


Fig. 1—Cross Section Showing Application of Coleman Safe End to Boiler Tube

The inherent objection to the common type of safe end, set by means of roller and Prosser expanders, is that the semi-circular corrugation on the water side of the tube sheet touches the copper ferrule at the edge only and cannot prevent more or less working of the tubes due to expansion and contraction. This working is bound to cause leaky tubes even when they are electrically welded and the results are serious and costly engine delays on the road and at terminals.

To overcome the above structural weakness, the Coleman tube safe end has a square shoulder, as shown in Fig. 1, which is pressed solidly against the copper ferrule and tube sheet. The tube sheet hole is slightly tapered (2¼ in. to the ft.) and the tube end is beaded over as usual. It will be obvious that the square shoulder prevents movement of the tube toward the firebox. The beaded end, in conjunction with the taper bearing, holds the tube against forward movement and this construction, by preventing any movement of the safe end in the tube sheet, eliminates leaks from this cause.

A comparison of the Coleman and the Prosser expander methods is shown in Fig. 2 and attention is called to the smaller tube sheet holes required. This results in wider bridges and therefore increases the strength of the tube sheet which will offer a greater resistance to stretching when the tubes are worked. Tools used for applying the Coleman safe end are the same as for the standard safe end, except that the Prosser expander is eliminated and a sectional expander with the correct taper substituted. A roller expander arranged to give the proper taper of 2¼ in. to the foot is used only on the initial installation of the tubes.

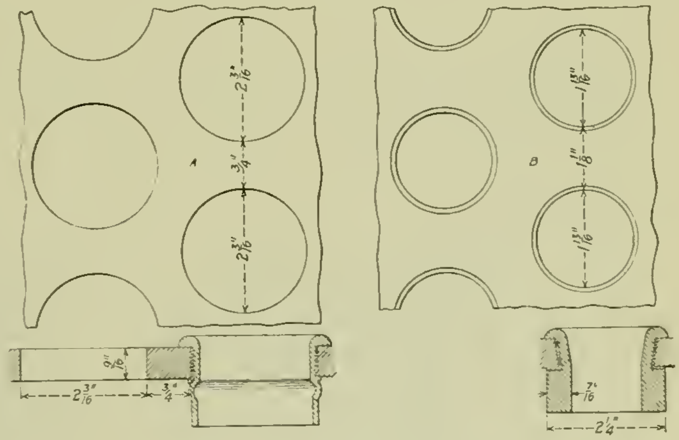


Fig. 2—Comparison of Prosser Expander and Coleman Methods

Elimination of the Prosser expander is an important advantage. After the old style tubes have been prossered two or three times, the tubes will be damaged by any further use of this tool unless exceptional care is taken. The use of a sectional expander without the Prosser, however, does not distort and weaken the tube nor cause it to crack on the water side of the sheet, as is often the case with the old style tube which requires frequent working to keep it tight. It is stated that owing to its structural design, the Coleman tube safe end requires about 10 per cent less working than the straight safe end which has been prossered.

In applying the new safe end to an old tube, the tube is shrunk on, as shown in Fig. 3, leaving a small space to be filled in and form the fused or welded joint. Either the electric or oxy-acetylene process may be used in making the weld, which is said to cost less than the ordinary lap weld and to be less likely to fail in service. The value of the Coleman safe end as a safety device is based on this claim.

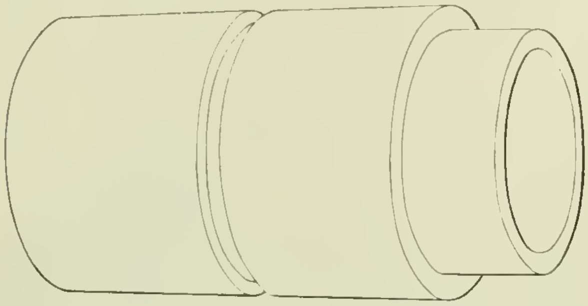


Fig. 3—New Safe End With Tube Shrunk on, Ready for Welding

Many tubes start to work in the tube sheet and leak soon after being applied because of sagging, especially when very long. Moreover, some tubes sag more than others, thus causing an uneven contraction and expansion. In order to prevent the above conditions, which are bound to result in leaks, a simple, inexpensive tube support has been designed as shown in Fig. 4. The first row of tubes is supported at the center on one continuous strip of iron properly bent and set on the bottom of the boiler. Above this row, individual supports of the form illustrated are used. Fig. 4 also shows a perspective view of the copper ferrule used with the new safe end.

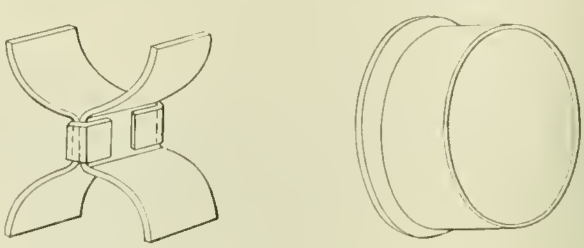


Fig. 4—Tube Support and Copper Ferrule

Careful tests indicate that the use of Coleman safe ends greatly increases the life of tubes over that obtainable with former methods of safe ending. In addition, leaky tubes are practically eliminated, thus reducing engine failures and delays on the road and at terminals. As a further important advantage, it is maintained that the decreased size of tube ends at the firebox tends to cause more complete combustion and make a better steaming locomotive; also one which burns less coal to develop the same tractive effort.

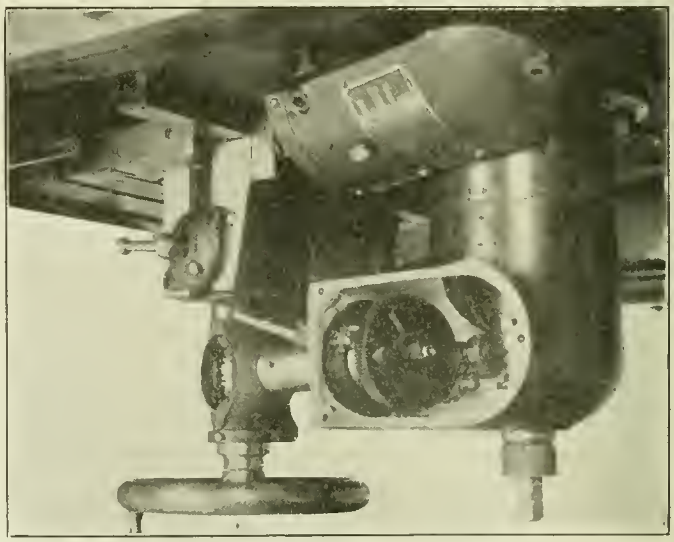
Two-Unit Feeding Device for Shapers

SIMPLICITY and sturdiness are features of the new feed for shapers introduced by the Queen City Machine Tool Company, Cincinnati, Ohio. The device consists of two units, the one at the bull wheel bearing regulating the amount, and that at the rail screw, the direction in which the table will be moved. At the end of the long bull wheel hub, a large face cam is mounted, revolving with an easy undulating motion and immersed in oil. The action of this cam through the large roller to the ratchet pawl is in a straight line, without links or intermediate parts, causing very little strain to the swinging arm that carries the roller.

The ratchet wheel is unusually large and drives the splined sleeve of the feed shaft through the medium of a safety friction. This is a great advantage, when it is considered how easily the table can be run to the limit of its traverse, or a wrench accidentally dropped where it will interfere with its working. If adjustments are necessary they can be made as easily as clamping the tool and with the same wrench, but powerful spider springs provide a driving pressure ample for all needs and an automatic "take up" for wear.

The swinging arm, mentioned as carrying the roller and pawl, has a large bearing on the outside of a sleeve which is pressed into the housing, upon the inside of which the double splined feed shaft sleeve is fitted. The swinging arm is held toward the cam by a long torsion spring. The amount of feed is controlled by a stop on the adjusting handle extension inside, which acts to limit the swing of the roller arm, the spring being automatically varied to the tension required by the movement of the handle. The feed controlling lever can be placed in zero position, at which point no part undergoes wear, or is in motion, and the movement of the parts is always proportionate to and no greater than the amount of feed which is being used throughout the sixteen changes provided.

The reverse box lever indicates, by its position, the direction in which the table will move and starts and stops the feed. The box contains the familiar bevel gear and clutch construction, the clutch teeth being integral with the gears and strongly proportioned, and the mesh of the gears being adjustable for wear. The use of a partition back of the cam, and the liberal use of felt oil retaining rings and wipers, makes practical the use of splash lubrication. The journals are all ground and of large proportions. The roller, pawl, ratchets, etc., are hardened and ground and the cam is accurately ground on a special machine.


Queen City Shaper Two-Unit Feed

The sliding connection to the rail is rigidly supported by a long sleeve. The driving keys are long and the shaft, by its position, prevents any binding tendency. All moving parts are enclosed and dust proof. The convenience of control is obvious, the feed always taking place upon the back stroke of the ram without attention or adjustment.

A strict schedule of interchangeability is maintained with a complete equipment of jigs and gages. It is stated that in a severe 55-hour test at excessive speed against a brake no weakness developed in this new feed.

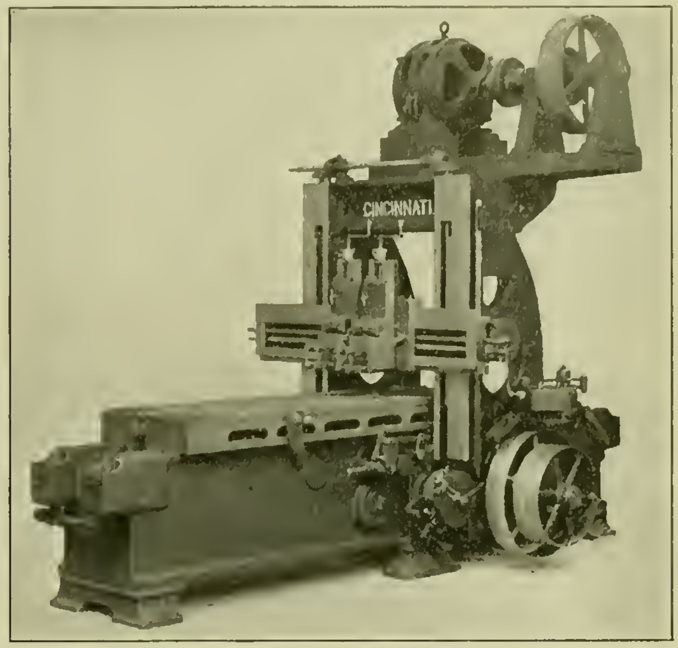
Thirty-Inch Shoe and Wedge Planer

Recent improvements in planer construction have been incorporated in the 30-in. shoe and wedge planer illustrated. The new machine, which is made by the Cincinnati Planer Company, Cincinnati, Ohio, is designed for heavy service and the extra heavy box bed has a cast closed top over its entire length except where the bull wheel meshes into the rack.

Herringbone gears and all steel gearing in the bed provide for uniform power transmission to the table and little possibility of interrupted service due to gearing troubles. All gears are well oiled by means of a force feed lubrication system. A deep and strong box table reduces the possibilities of springing and getting out of shape to a minimum. For convenience when setting up work, the stop holes are drilled all the way through the upper half. This saves time usually required for cleaning out stop holes before inserting a stop. The lower half, which is cast solid, prevents the dust and chips from falling through and into the vees.

Each housing extends to the bottom of the bed and is fastened in correct alinement to the side of the bed by means of a tongue and groove, bolts and dowel pins. The faces of the housings are exceptionally wide to provide a proper bearing surface for the back of the rail. A heavy box arch, provided for tying the housings together at the top, affords increased strength and rigidity. As noted, the saddle has a wide bearing surface on the rail.

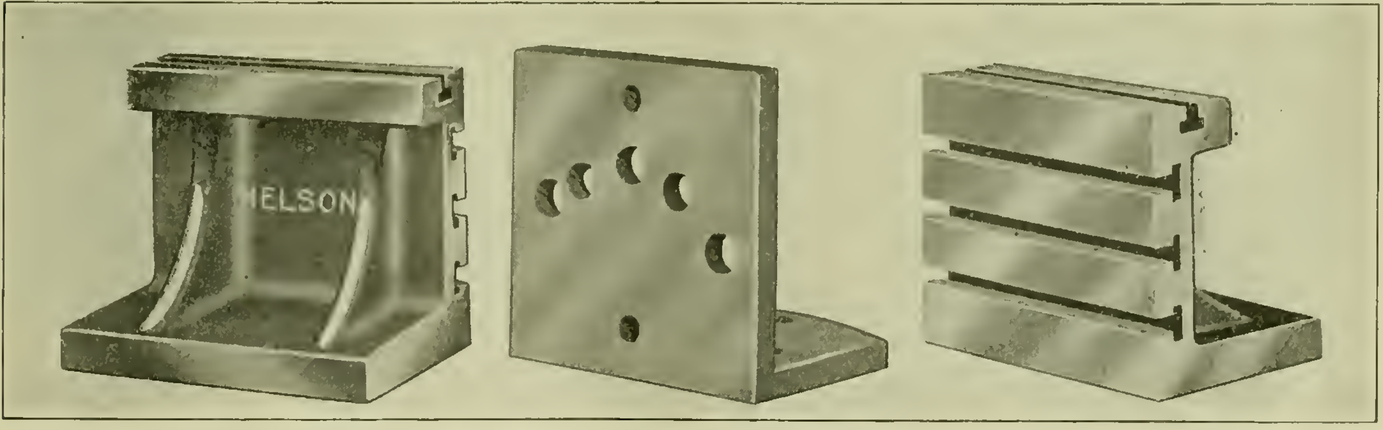
Both tool heads are mounted on one saddle, causing them to move crosswise in unison, but provision is made for moving them up and down independently by hand or by power. The widened bearing surfaces, in addition to the exceptional weight, strength and rigidity of all parts, assures a rigid cutting tool and a firm, smooth planing action. The new planer is regularly equipped with a two-speed counter shaft but can be conveniently arranged for plain or variable speed motor drive as shown in the illustration.



Cincinnati 30-In. Shoe and Wedge Planer

Angle Plate With Second Face and T-Slot

An additional face and T-slot have been provided on a 90 deg. angle plate manufactured by the Nelson Tool & Machine Company, Newark, N. J., and placed on the market recently by the Fairbanks Company, New York. This angle plate is made of high grade iron machined accurately and true to master plates, all T-slots being formed by milling. By means of an additional T-slot in the second face, work can be strapped in either of two planes, whichever is more convenient for the rapid, accurate machining of the piece. Nelson angle plates are made in four standard siges: 3 in. by 3½ in., 6 in. by 9 in., 10 in. by 12-in. and 14 in. by 18 in.; larger sizes are made to order. They are adapted for use on shapers, planers, millers, drill presses and other machine tools in railroad shops.



Comparative Views of Nelson and Home Made Angle Plates

Advantages of the Nelson 90 deg. angle plate as compared to a home-made angle plate are indicated in the illustration and include greater rigidity, greater ease of set up and adaptability to a greater variety of work due to the second holding face. It may be that the first cost of the home-made angle plate is low, but the final cost is high if account is taken of the time lost in setting up jobs with this type of angle plate which necessitates looking for special clamps and drilling holes for nearly every job.

With railroad shop machinists receiving 85 cents an hour for their time, it is evidently good economy and wise shop management to furnish an ample supply of jigs and fixtures which will facilitate machine operations and eliminate as far as possible time spent in setting up work. In many cases special jigs and fixtures can be manufactured locally in the shop where they are to be used, but when such home-made jigs are not as effective time-savers as similar products on the market at a reasonable price, the latter should be purchased and allowed to earn dividends on their own cost and on the cost of expensive machines with which they are used.

Bolster Attachments for Metal Draft Arm

The reinforcement of wood cars having weak draft sill and center construction has received much attention during the past few years. One of the most common methods of reinforcement is by the application of some form of metal draft arm. The application of such arms, of either structural or cast steel construction, in many cases makes practicable the retention in service of classes of equipment which otherwise would be too weak to withstand successfully the severe shocks of modern operating conditions.

In developing a program of reinforcement to these old wooden cars it may frequently occur that several classes of equipment with varying dimensions may be involved. In order that a minimum number of separate draft arm designs may be developed to meet the requirements of all classes of equipment involved in a given program and to provide a thoroughly satisfactory means of attachment of the draft arms to the bolsters, a scheme for the use of filler blocks and shims to compensate for the variations in the dimensions and location of the bolsters, without requiring a change in the draft arm itself, has been developed and patented by R. C. Taft, Moline, Ill. In all ordinary cases the scheme presupposes two designs of draft arms, one for all classes of high cars where the bolster passes under the center sill and another for all classes of low cars where the line of draft is between the center sills with a few possible exceptions. The proportions of these draft arms may be worked out on the basis of a composite diagram showing the location of the body bolster with respect to the end sill and its width and depth, for each class. The openings of the recesses in the draft arms are then designed to suit the maximum dimensions of the composite diagram.

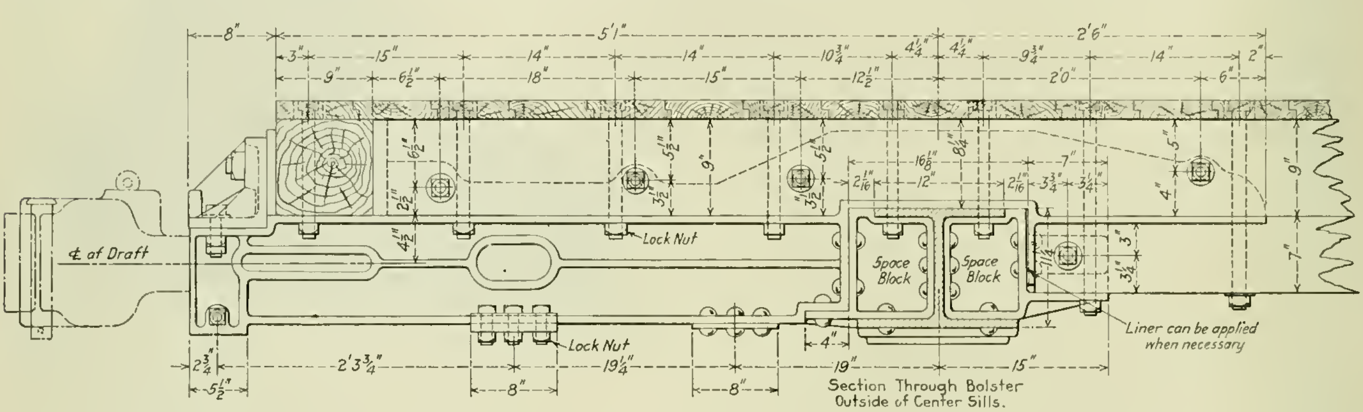


Fig. 1—Application of Spacing Blocks to a Cast Steel Draft Arm

In order that the draft arms thus standardized may be attached rigidly to the bolster in each case, filler blocks or shims, or a combination of the two, are designed for insertion between the bolster and the faces of the recess in the draft arm so that an unbroken metal path is provided between the draft arm and bolster for the transmission of buffing and pulling stress.

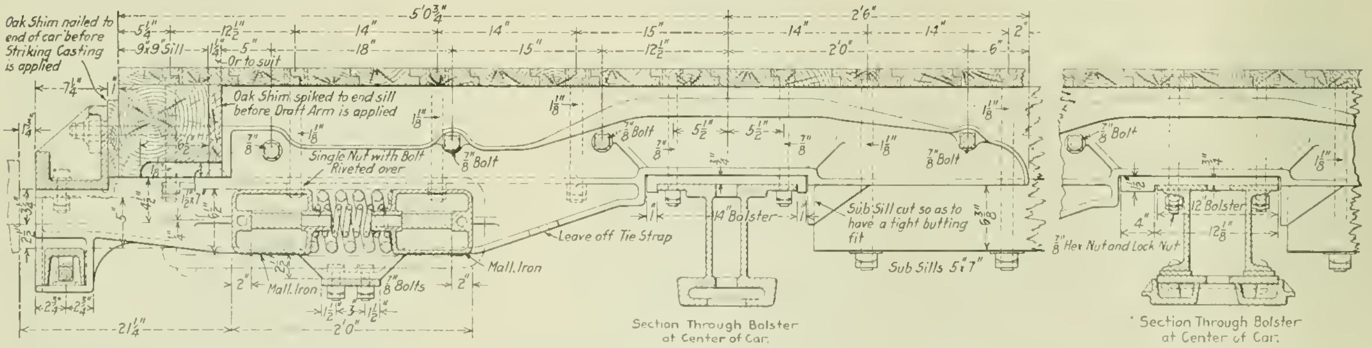


Fig. 2—Application of Shims With Cast Steel Draft Arms to Body Bolsters on High Cars

A typical application of cast spacing blocks in connection with a cast steel draft arm is shown in Fig. 1. Here it will be seen that the blocks are cast to fit the contour of the channels between the flanges and web of the H-section cast steel bolster, and that the forward spacing block is provided with a horizontal flange which is riveted to the bottom flange of the draft arm. Similarly, the rear spacing blocks have horizontal flanges extending under the ends of the sub-sills, which are butted against the rear vertical flanges of the bolster pocket in the draft arm. It will readily be seen that by variations in the dimensions of these filler blocks the same draft arm may be applied to cars with considerable variations in the location and dimensions of the body bolster.

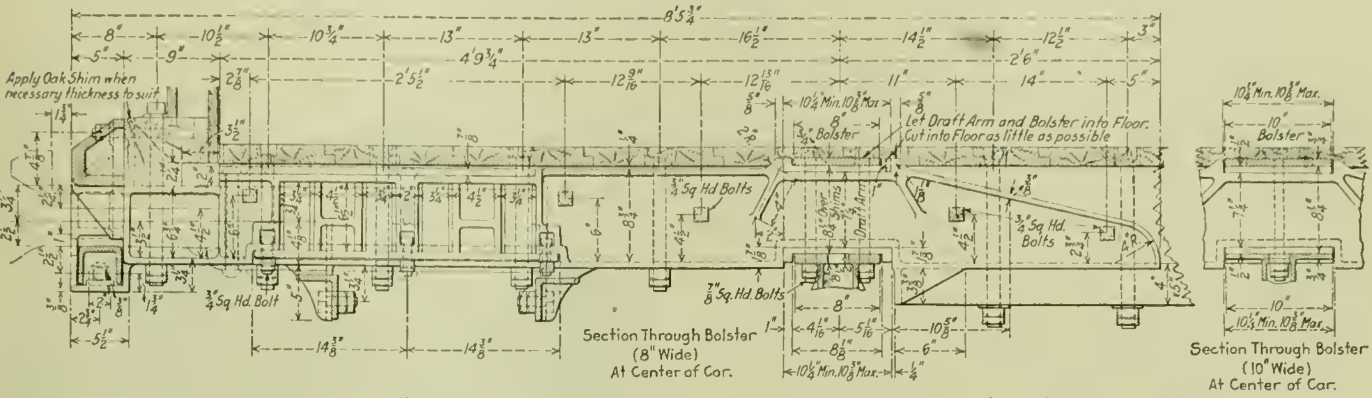


Fig. 3—Application of Shims With Draft Arms to Body Bolsters on Low Cars

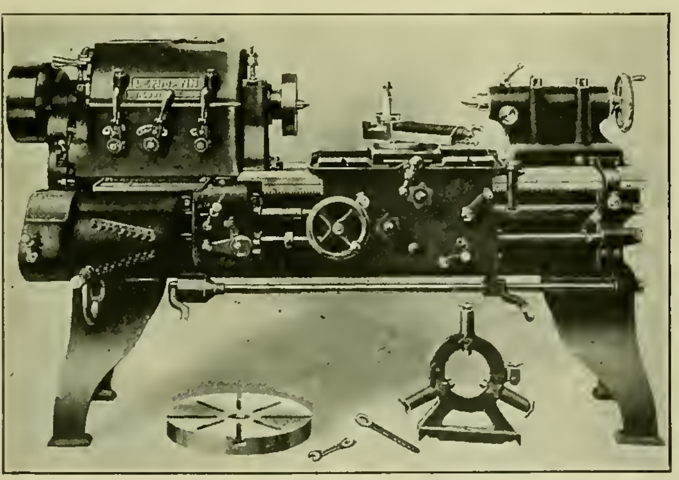
The use of shims instead of filler blocks on a similar application is illustrated in Fig. 2. This drawing clearly shows the method of adapting the draft arm to two sets of conditions. The flanges on the shims provide a complete metal-to-metal structure through the top or tension member of the bolster, for resisting stresses on the direct line of draft.

The method of using shims in the case of low cars, where the line of draft and the draft arm pass through instead of over the bolster, is shown in Fig. 3. These shims may be varied in dimensions as required to suit the relation of the bolster to the recesses in the draft arm.

Either the cast blocks or the shims may be utilized in the application of steel underframes to wood equipment. Their use has the same advantage of a standardized underframe design, a minimum of alteration in the car itself, and the solid anchoring of the bolsters in the underframe that obtains in the case of draft arm reinforcement.

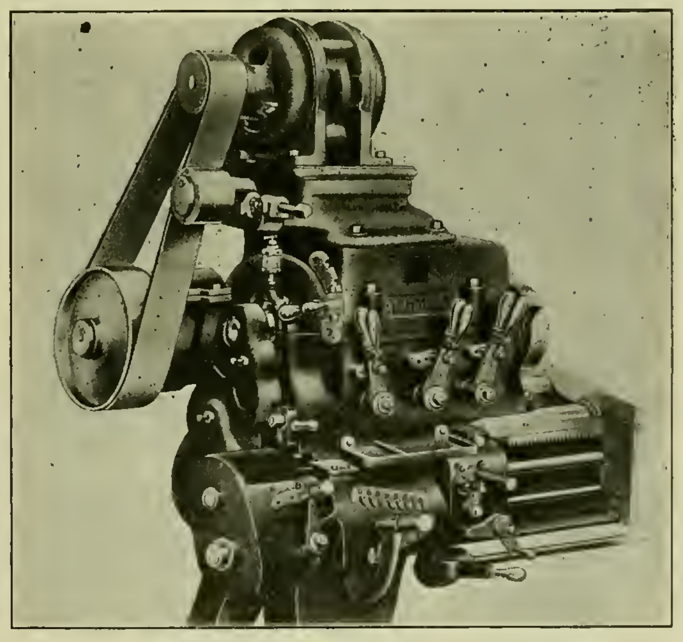
Compact Selective Head Engine Lathe

For toolroom work, especially where it is desirable to have a large number of speeds available, the improved, geared-head engine lathe manufactured by the Lehmann Machine Company, St. Louis, Mo., will be found well adapted. The lathe is built in a number of sizes and 16 spindle speeds are provided, ranging from 10.5 to 422 r.p.m. on the 16-in. lathe, and 8.5 to 330 r.p.m. on the 22-in. machine. These speeds are in almost exact geometrical proportion and are obtained without the use of a countershaft. Tooth travel of the 10 gears used in the head stock is moderate at all spindle speeds, which tends to make a quiet running machine. No safety or interlocking device is required to avoid engagement of different gear ratios at the same time, as the particular design makes it impossible for this accident to occur.



Lehmann Selective Geared Head Engine Lathe

Made of high carbon steel and running on ball bearings, all shafts with sliding members are provided with four keys milled integral with the shaft. Each shifting member is operated by a ring which runs in a groove completely encircling it, the compensating mechanism which connects the ring with the operating shaft being of substantial construction. Gear ratios of 57.1 to 1 and 70.6 to 1 are provided on the 16-in. and the 22-in. lathe respectively. This gear ratio permits the use of a high speed driving shaft and the large diameter driving pulley which gives a desirable belt speed and reduces the strain on belt and bearings. All part of



View Showing Application of Motor Drive

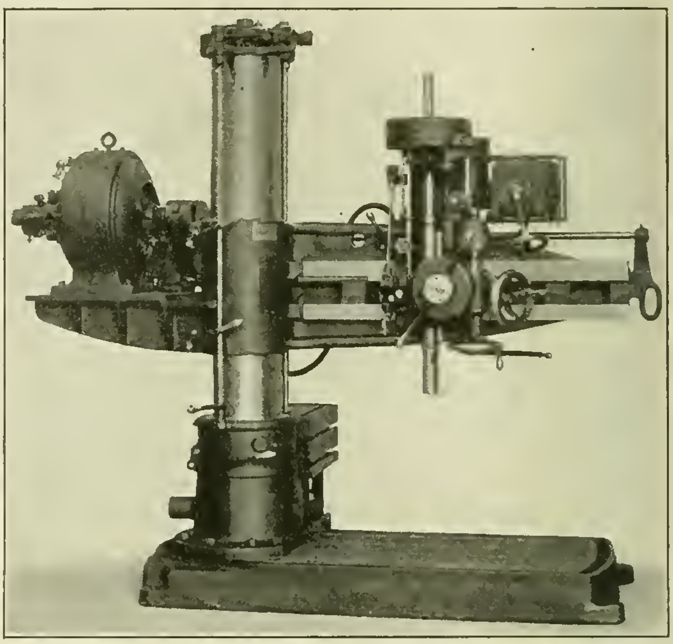
the head stock are designed to transmit power for the heavy cuts which can be taken on this machine.

The most popular drive for Lehmann lathes is a direct drive from a motor mounted on the head stock. Power is transmitted through a short belt and idler running on ball bearings and having ample arrangements for adjustment. With the fast belt travel this is found to be a satisfactory drive and no trouble is experienced on account of the short belt. In fact, the belt pull is much less than usual on account of the large diameter and high speed of the driving pulley. A high speed motor operating at 1800 r.p.m. is used, with a suitable guard provided for the belt and pulleys. If desired, motor drive can be furnished with the motor mounted on a base hinged to the leg of the lathe.

New Drive for Heavy Duty Radial Drill

A RECENT development of the Fosdick Machine Tool Company, Cincinnati, Ohio, is the new type of motor drive furnished on the company's 4, 5 and 6-ft. heavy duty radial drills. The illustration shows the Fosdick 4-ft. heavy duty radial drill with a 5-hp., three to one variable speed motor, on the arm, and a Cutler-Hammer controller directly on the spindle head. The saving of power through the elimination of two sets of bevel gears is a big advantage; also the location of the motor away from dirt which accumulates about the floor. The swinging arm is partially balanced, and additional floor space about the base is available.

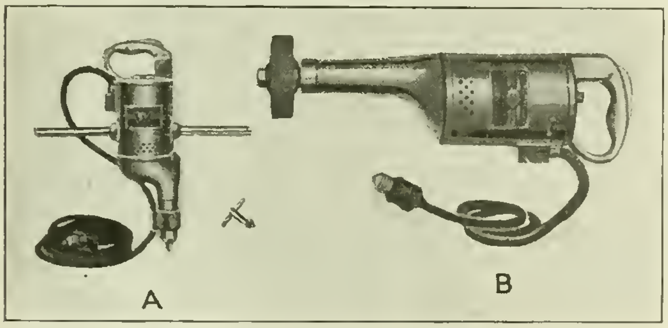
The outstanding feature of this particular application is the standardized drive; that is, three to one variable speed motors of any standard make or speed may be used, thus avoiding the customary delay caused by making special patterns and castings for each particular type of motor. A Bakelite pinion on the motor shaft varies in size according to the speeds of the motor as selected. All other gears (aside from the elimination of the bevel gears) are kept standard. Special stress is laid on the fact that but one motor is used. The elevating mechanism is driven from this same motor through the regular standard gear arrangement, whereby all the safety devices are retained.


Fosdick 4-Ft. Heavy Duty Radial With New Motor Drive Arrangement

The controller, as shown mounted on the spindle head, is made more convenient of operation by the bevel gear connection to the handwheel below it. This type of control is preferred in shops where the work is usually on large castings with the spindle head frequently at the upper and outer extreme travel. A more popular location for the controller is on the arm girdle, convenient to the operator's left hand. This eliminates the large flexible conduit as seen in the rear of the arm, and is the most satisfactory position for the average run of work.

Portable Electric Drill With Automatic Switch

A LINE of portable electric drills and grinders, in which automatic power control similar to that in general use on all portable pneumatic tools, has recently been developed by the Wodack Electric Tool Corporation, Chicago. The special feature of these tools is the switch, the operating member of which forms part of the hand grip, so arranged that the pressure of the operator's hand closes the switch and is required to maintain it in the closed position. With the release of the operator's hand from the grip, the switch automatically opens. The switch itself is designed as a complete unit separate from the drill case and is enclosed in the vertical support at the front end of the hand grip.



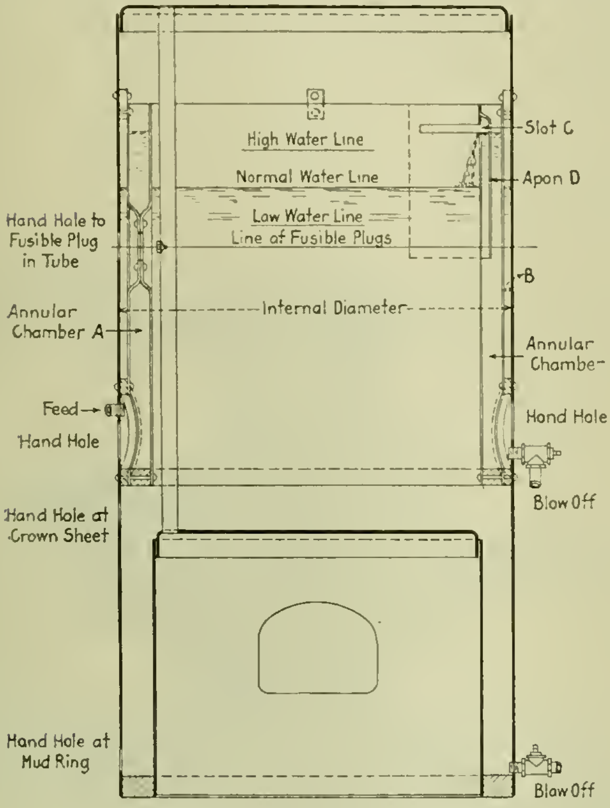
Wodack Portable Tools Equipped with Automatic Stop Feature

The motor and gear casing is of aluminum and a ventilating system is provided by which a positive flow of air is drawn into the casing, over the motor windings and forced out of the casing. In the design of these tools attention has been given to the elimination of screws, bolts and nuts to the fullest possible extent. In the design of the brush holder care has been taken to avoid the possibility for the accumulation of oil and grit and oiling is required only when the carbon brushes are changed. The gears and shaft are of chrome nickel steel and full ball bearings have been provided throughout.

The drills, one of which is shown at *A* in the illustration, are rated in six sizes ranging from 3/16-in. to ¾-in., and are said to deliver about 25 per cent more power than indicated by their ratings. The grinder, shown at *B*, is made in two sizes, one of which takes a wheel 3 in. by ½ in. by ½ in. and the other a wheel 4 in. by 1 in. by ⅞ in. The weight of the drills ranges from 5 lb. for the 3/16-in. size to 20 lb. for the ¾-in. size while the grinders weigh 5 lb. and 15 lb. respectively.

A Scale-Proof Locomotive Crane Boiler

For many users of locomotive cranes the largest single item of upkeep expense is the washing and maintenance work on the boiler. At best there is no ideal boiler feed water and locomotive cranes, working in sections remote from the central supply of purified boiler feed water, or on contract jobs where no purification plant is available, often are forced to use extremely poor water to feed into a boiler.



Parker Scale-Proof Locomotive Crane Boiler

The Industrial Works, Bay City, Mich., builders of the Industrial locomotive and wrecking cranes, are now building locomotive crane boilers equipped with an annular scale chamber placed between the tubes and the shell plate. The feed water is slowly passed through this scale chamber (at about 1/200 of the speed through the intake pipe) and attains a temperature at which the scale forming impurities will be liberated from solution without the use of any chemicals. The impurities are then carried in suspension and as the movement of the water is very slow these suspended precipitates settle down readily to the bottom of this chamber. This settling is accelerated by the decrease in density of the water as it is heated and by the decrease in its fluid friction.

The details of this design are fully indicated in the sectional view. The purifier consists of the annular scale chamber *A* extending completely around the tubes with a one-inch water space *B* between this chamber and the boiler shell. The outlet into the main portion of the boiler is the slot *C* guarded by the apron *D*. The feed water is admitted directly to the scale chamber *A* at a point farthest from the outlet slot.

It travels slowly around this chamber to the outlet and reaches approximately the boiler temperature before overflowing. The apron *D* keeps any floating impurities such as grease, oil, etc., from being discharged into the main boiler.

The sulphates of calcium are the hardest of the scale forming impurities to eliminate. They are precipitated at 280 deg. F., corresponding to the boiler temperature when holding the steam at only 35 lb. gage pressure. The carbonates and magnesia are precipitated at lower temperatures. These are all caught in the scale chamber together with mud, oil, and, in fact, all solids except common salt, for the first application of heat causes the liberation of these solids in the boiler over the crown sheet as well as in the scale chamber.

The scale forming impurities left in the scale chamber do not bake into scale as they do not come into contact with the hot furnace sheets, but they are left in the bottom of the scale chamber as soft mud, where they may be readily removed by blowing or washing out, quickly and easily, at the operator's convenience. It is stated that numerous tests have demonstrated the efficiency of this purifying device. In one test of a 42-in. diameter boiler of this type made at Paterson, N. J., a feed water naturally carrying 5 grains per gal. was loaded with 70 grains of calcium and 70 grains of earth, a total of 145 grains per gal. The feed water was taken from a barrel agitated with carbonic acid gas to form calcium carbonate. After about 1,200 gal. of this kind of water had been passed through the boiler, it was allowed to cool and the heating surfaces and lower mud ring were found to be perfectly clean and the mud was about six inches deep in the scale chamber. The blow-offs were both plugged so all impurities remained in the boiler. It was interesting to note that the presence of so much precipitated impurity in the scale chamber did not interfere with its operation.

This type of boiler was designed and patented in 1919 by Thomas T. Parker and has proved its value in utilizing all kinds of feedwater.

Redesigned Carbon Dioxide Recorders

Coincident with the present acute interest in fuel economy and more efficient boiler operation, the Uehling Instrument Company, New York, has introduced a new model CO_2 recording equipment, known as style U, which embodies important improvements over the superseded model. Chief among its advantages are remarkably quick action, greater accessibility and simplicity of parts, and the economy of combining in one machine means for determining CO_2 simultaneously from any number of boilers, up to a total of six.

A single unit equipment for one boiler consists of three principal parts: namely, the CO_2 meter proper, recorder and auxiliary boiler front indicator. The meter is placed wherever is most convenient and its function is to actuate the boiler front indicator and recorder in the engineer's office. The flue gas is analyzed, that is, the CO_2 is extracted, in the meter and the principle involved in the operation depends upon the change in pressure caused by a change in volume in a stream of gas flowing through two apertures. In the new model the gas travel is hastened by utilizing the exhaust from the main aspirators in an auxiliary aspirator, while the main aspirator draws the gas sample through the absorption chamber. This prevents lag in the travel of gas from the boiler up to the absorption chamber.

With each unit is included a preliminary filter which removes soot and dirt from the sample before it reaches the intermediate and final filters on the machine. This has been redesigned so that the filter chamber can be conveniently cleaned in a few seconds without interrupting operation of the machine.

Multiple equipments combine in a single outfit means for measuring CO_2 from two, three, four, five or six boilers independently and simultaneously. It is most economical to equip the boilers in batteries of six each, but this is not absolutely necessary, inasmuch as the CO_2 meters are now built on the unit plan and may be added to from time to time. With multiple unit machines, each boiler is equipped with its own recorder, auxiliary boiler front indicator, preliminary filter and absorbent chamber with necessary appurtenances, but the aspirator and other parts of the master unit serve all units in common.

The recorder operates on the hydrostatic principle, and thus all springs, levers and joint movements are avoided. It makes a continuous record of the per cent of CO_2, furnishing an autographic history of the operation of each boiler for every second of the day, showing when fires receive attention; when and how often furnace doors are opened, or how often stoker speed and fuel bed thickness are changed; fires broken and cleaned; effects of changes in damper regulation and methods of firing.

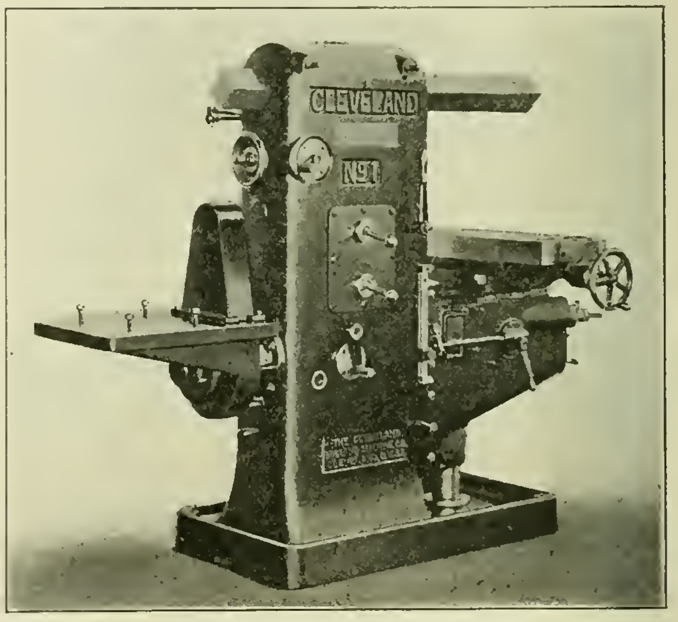
The boiler front indicator guides the fireman in supplying just the right amount of air to burn the fuel with the least loss of heat up the chimney. Uehling carbon dioxide equipment may also be combined with Uehling pyrometers to give continuous records of both carbon dioxide gas and stack temperature on the same shart.

Motor Drive for Milling Machines

ONE of the latest developments of the Clark-Mesker Company, Cleveland, Ohio, has been in applying mator drive to the Nos. 1 and 2 Cleveland milling machines. A friction clutch is provided in the drive between the sprockets and the chain, and the main drive shaft of the machine, which affords all the advantages of belt drive. The sprockets and chain run in oil and it is a simple matter to change over from the ordinary belt drive to electric motor drive by replacing the pulley housing with a bracket.

A constant speed motor is used running at about 1,200 r. p. m. The Morse chain used for the motor drive on the No. 1 machine is 2 in. wide and that on the No. 2 machine 2½ in. wide. The illustration shows that the motor is well up from the floor, away from dirt and chips, but not high enough to make the machine top heavy. An adjusting nut on the back of the motor drive housing is provided for adjusting the friction clutch for the main drive.

By this new development, all the advantages of individual electric motor drive are secured not only for users of new No. 1 and No. 2 Cleveland milling machines but for those already operating belt driven machines. The time and expense required for changing over will in many cases be far less important than the elimination of belt troubles and the more convenient placing of the machines.

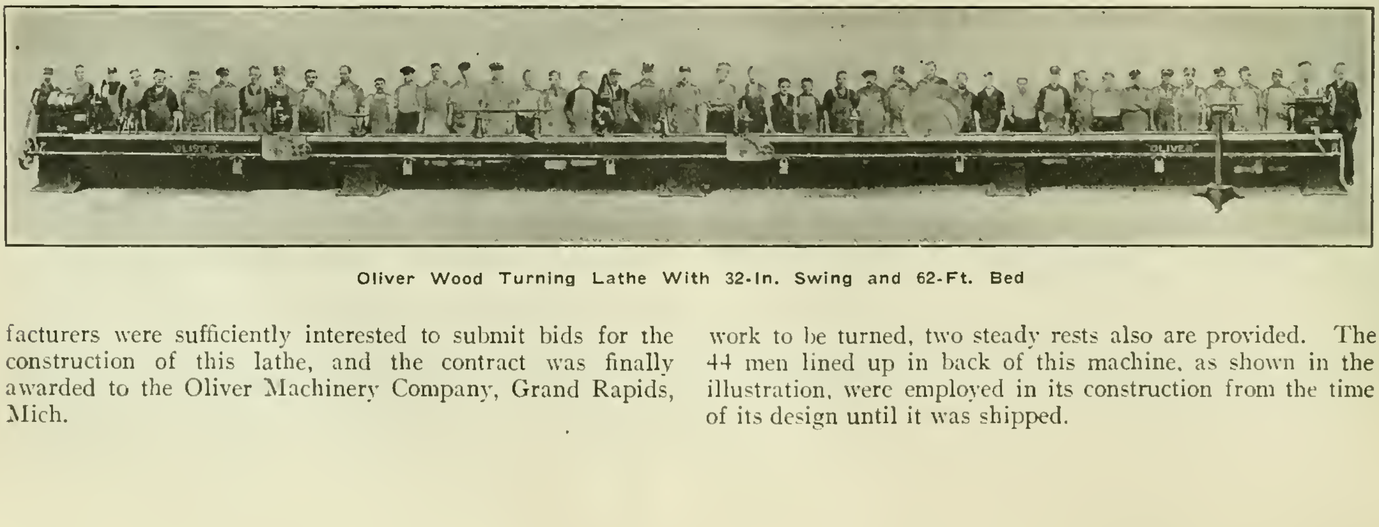


Milling Machine Arranged for Electric Motor Drive

Wood Turning Lathe of Unusual Length

THE wood turning lathe illustrated herewith was built in accordance with specifications written for the United States Government during the year 1919. The lathe was designed for the turning of spars or ship masts and has a swing of 32 in. and a bed 62 ft. long. Only two manufacturers were sufficiently interested to submit bids for the construction of this lathe, and the contract was finally awarded to the Oliver Machinery Company, Grand Rapids, Mich.

The bed of the lathe is cast in four sections, being supported upon five pedestals as indicated. Belt drive is secured from overhead shafting through four-step cone pulleys. Two power feeding carriages are provided; also several adjustable tool rests. In order to support the long and heavy work to be turned, two steady rests also are provided. The 44 men lined up in back of this machine, as shown in the illustration, were employed in its construction from the time of its design until it was shipped.

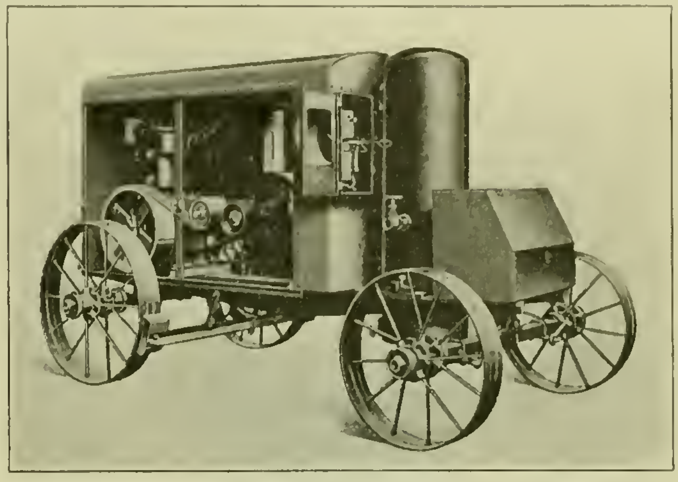


Oliver Wood Turning Lathe With 32-In. Swing and 62-Ft. Bed

Compact Portable Air Compressor Units

Users of compressed air who are located at a distance from the central power stations must avail themselves of some type of portable air compressor. The Imperial portable compressor made by the Ingersoll-Rand Company, New York, is designed to meet the needs of this class of service. For gasolene power, these units are driven by tractor type gasolene motors and are built in three sizes, with capacities of 45, 118 and 210 cu. ft. per min. For use where electricity is available as motive power, an electric motor driven Imperial compressor has been designed. This unit is of 118 cu. ft. capacity and weighs approximately 4,450 lb., depending upon the weight of the motor. As in the case of the corresponding gasolene motor driven compressor, this electric unit is of all-steel construction. Light steel doors, easily removed, and a sheet steel canopy completely house the entire unit, protecting it from the weather and preventing undue deterioration from rust.

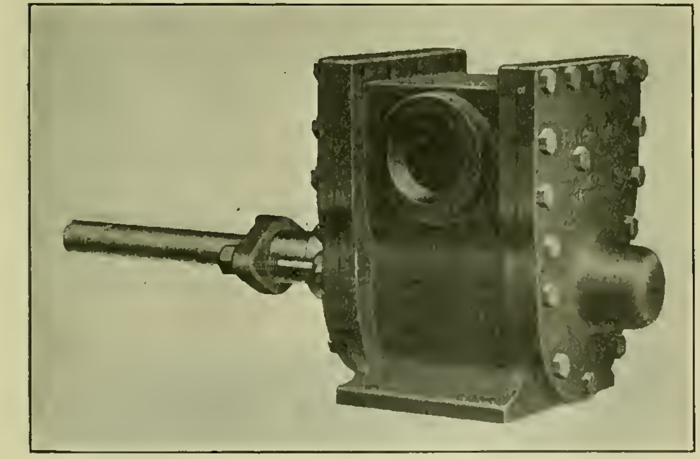
Either an alternating or a direct current motor can be furnished and a suitable intake unloader is provided, assuring efficient regulation. In any case, the motor control is in accordance with standard practice and specifications covering the type of motor used. Additional equipment includes an air receiver, safety valve, drain valves, pressure gage and service valves to which air hose lines may be connected.



Portable Air Compressor with Capacity of 118 Cu. Ft. per Min.

Efficient Rotary Piston Type Pump

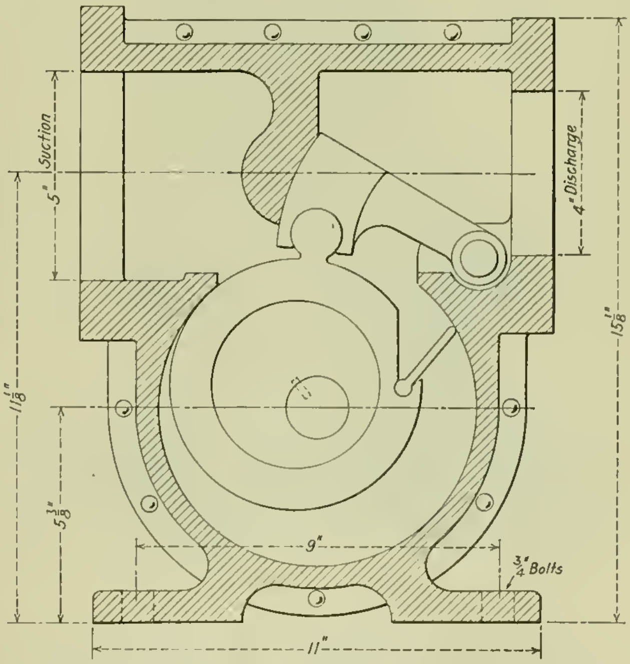
In the design of the rotary piston pump manufactured by the St. Louis Pump & Equipment Company, St. Louis, Mo., special attention has been given to the correction of weaknesses most common to pumping devices used for handling volatile and non-volatile liquids. The pump is simple, durable and stated to be unusually efficient; the best features of the rotary pump being combined with the best features of the piston pump.



St. Louis Rotary Piston Type Pump

There are only twelve major parts, consisting of a pump case with dividing partition, two end plates, a steel shaft with two eccentrics mounted thereon, two pistons, two rocker arms and two checks. Two chambers or cylinders are arranged, with a shaft passing through the center of each, two eccentrics, directly opposite in throw or 180 deg. apart, being mounted on the shaft. Surrounding these eccentrics and pivoted to the rocker arm are the two pump pistons. The arm serves to produce the reciprocating movement of the piston through the cam action of the eccentrics. Thus a composite reciprocating and rotary motion of the pump plunger or piston is obtained without actual contact of the piston and cylinder walls. The clearance, however, is small and a liquid seal results, giving vacuums up to 29 in.

The piston check is the only moving part touching the cylinder walls and this functions only at the point of transition at the end of the pumping suction movement or stroke to the beginning of a new stroke. The wear on this check is taken up automatically. The interval between the so-called strokes is so slight that an even impulse is imparted to the liquid handled. While the piston is discharging, it is acquiring fresh liquid on the opposite or suction side, and the piston in the opposite chamber is functioning conversely, thus giving balanced action.



Cross Section Showing Operating Parts

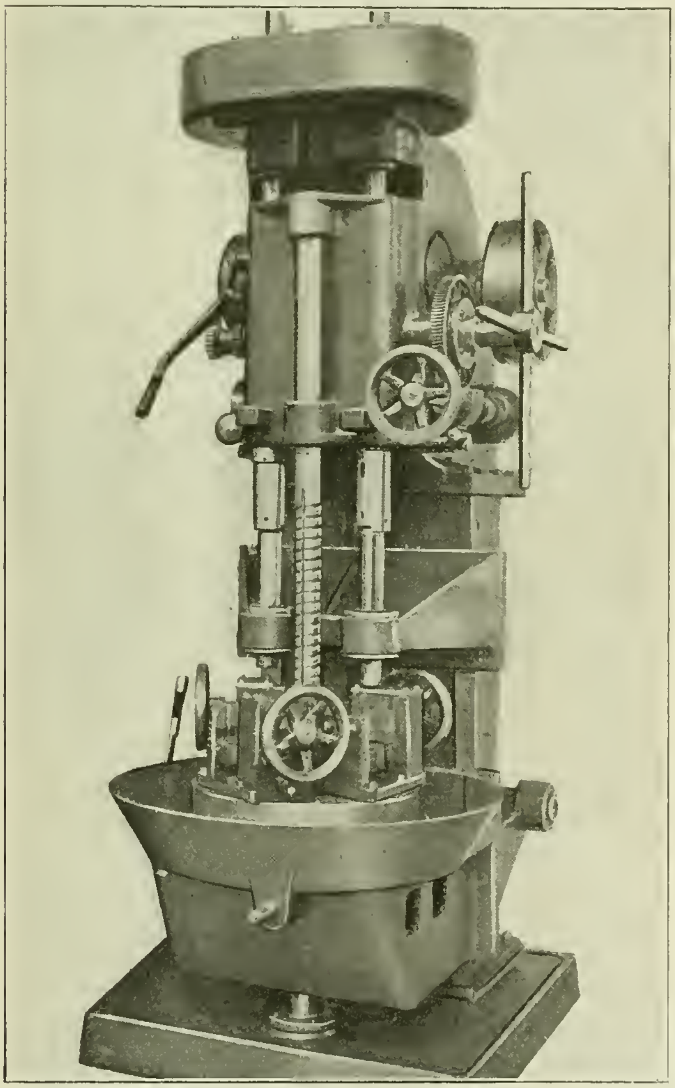
The construction is entirely of metal most suitable for the liquids handled, so arranged that no two similar metals are in contact at any bearing point. All wearing parts on the pump are rotative and at every point at which wear may be encountered even to a minor degree, self-lubricated bearings capable of long service are used.

The head at one end of pump case is blind; that is, the shaft does not extend through and this eliminates packing. At the other end, a gland which holds the packing material, is bolted to the head. The pump is compact, light in weight, practically free from vibration, durable and self-lubricating when handling either volatile or non-volatile oils or similar liquids.

Baker Boring and Drilling Machine

A TWO-SPINDLE machine designed especially for work having successive operations such as drilling, reaming, boring, counterboring, turning and facing, has been placed on the market by Baker Brothers, Toledo, Ohio. It consists of two spindles feeding simultaneously to work that is chucked on a circular indexing table. Three stations are provided so that the work is loaded and unloaded while the machine is in operation. Except for the very short indexing time, the machine is in constant operation and turning out work.

The spindles feed simultaneously but have independent speeds, thus driving each tool at its most efficient speed. Speed and feed changes are obtained by slip change gears, the drive being upon annular ball bearings. The principal specifications are: capacity, to drive 2-in. high speed drill; distance from center of spindle to face of column, 12¼ in.; distance from center of spindle to center of spindle, 10½ in.; length of feed, 12 in.



Baker Two-Spindle Drilling Machine

It seems probable that this machine would be adaptable to a variety of operations in railway machine shops, such as drilling and tapping nut blanks, drilling the many holes in brake hangers and rigging and many other similar operations.

Twenty-nine Passengers, 93 employees and six other persons were killed in train accidents during the second quarter of 1920 and 1,271 passengers, 690 employees and 23 other persons were injured; a total of 128 persons killed and 1,984 injured. Adding casualties in train service accidents—1,323 killed and 12,383 injured; and those in non-train accidents—112 killed and 25,398 injured—we have a total of 1,563 persons killed and 39,765 injured. The number of collisions reported in this quarter was 2,189 and of derailments 4,952. Adding miscellaneous accidents to trains we have a total of 7,883 accidents with total damage to cars and roadway of $7,762,500.

For the Good of Both the railways and the employees the thing most needed in the railroad field is an increase in the economy and efficiency of operation. The thing most needed to bring this about is an increase in the efficiency of labor. Probably nothing will contribute so much toward increasing the efficiency of labor as a better understanding by the managements and the men of one another's problems and points of view. The best way to bring about a better understanding will be for the officers and representatives of the employees of the various individual railways to get together and frankly talk over their mutual problems. Whether or not national agreements or national boards of adjustment exist under private operation, the efficiency and loyalty of the employees of the individual lines will depend largely upon the fairness and frankness with which the managements deal with them, and frequent conferences between the officers and representatives of the men can hardly fail to beget fairness and frankness on both sides.—*Railway Age.*

* * *

Photo by International

The Naval Balloonists, Who Were Lost in the Canadian Wilds, on Their Way Home

Railway Mechanical Engineer

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WE GUARANTEE, that of this issue 10,300 copies were printed; that of these 10,300 copies 9,243 were mailed to regular paid subscribers, 9 were provided for counter and news company sales, 265 were mailed to advertisers, 32 were mailed to employees and correspondents, and 751 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 20,500, an average of 10,250 copies a week.

The *Railway Mechanical Engineer* is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

The directors of the American Railway Association, at a meeting in New York on January 6, elected Daniel Willard (B. & O.), chairman of the board and re-elected R. H. Aishton president of the association. W. G. Besler (C. of N. J.), was chosen first vice-president, in place of W. T. Tyler, and Hale Holden (C. B. & Q.), second vice-president, in place of E. H. Coapman. J. E. Fairbanks is general secretary and treasurer.

The total deficit for all the French railways for 1920 will be about $900,000,000, the operating ratio during the year being in the neighborhood of 125 per cent. The total number of employees has increased from 355,900 in January, 1914, to about 500,000; the amount of money paid out in wages meanwhile has increased 327 per cent. The greater part of the railways destroyed in northern France have been reconstructed and are now in operation.

The Chicago, Rock Island & Pacific has appointed a general reclamation committee, of which C. A. Morse, chief engineer, has been appointed chairman, and is conducting a campaign among its employees for the conservation of materials. The committee is not only urging employees to save on new materials, but also that all articles in need of repair be gathered up and shipped to the shops and that all scrap be moved as well. Under the direction of the committee the system has been placarded with posters advertising the drive.

The Chicago Safety Council recently organized a Steam Transportation Committee, which held its first meeting on December 21. At this meeting a general discussion took place as to the general activities which the committee would undertake. It was explained, however, that it was the intention that action should be taken as heretofore by individual roads regarding specific matters and an attempt be made to bring about the desired improvement or adjustment without referring matters to this committee for handling, except in special cases. C. L. Hinkle, general manager of the Chicago Great Western, is chairman of the committee, the personnel of which is representative of all the railroads in the city. Meetings of the committee are to be held once each month on the second Friday of the month at 12:30 p. m. in the Hotel Sherman, Chicago.

The pension list of the Philadelphia & Reading, established in 1902, now contains 485 names, of whom four have records of 57 years or more of service, and 72 others served 50 years or more. In the last issue of the "Roll of Honor," A. T. Dice, president of the road, expressed the management's appreciation of the long and faithful service these men had rendered. He said: "The prosperity which our company has enjoyed is due in no small part to your faithful service. Accordingly, it is just and right that you should share in that prosperity. You are entitled, also, in your retirement, to the satisfaction of knowing that by your work you have largely contributed to the upbuilding of the strong and important system of railroads we are now operating. The troublous times through which our country has passed since the beginning of the great war make clearer than ever before the value of efficient railroad service, and the vital interdependence of the country and the railroads."

Executive Committee Meeting of C. I. C. I. & C. F. Association

The Executive Committee of the Chief Interchange Car Inspectors' and Car Foremen's Association of America will meet at the Hotel Sherman, Chicago, on Thursday and Friday, March 3 and 4. The entire membership is invited to this meeting to suggest changes in the A. R. A. Rules of Interchange.

Engineering Council and A. S. M. E. to Meet in Syracuse

Herbert Hoover will be the principal speaker at a meeting in Syracuse, N. Y., on February 14, at which it is expected the plans of the American Engineering Council for dealing with industrial relations and, particularly, with the waste due to unemployment will be outlined. On the following day, February 15, the National Council of the American Society of Mechanical Engineers will meet.

Coal Production

The railways during 1920 transported the largest amount of bituminous coal ever handled by them in any calendar year except in 1918. The statistics of the United States Geological Survey regarding the amount of bituminous coal produced and transported up to December 18 of each of the last four years are as follows:

1917..............	536,288,000 tons	1919..............	441,592,000 tons
1918..............	566,349,000 tons	1920..............	537,555,000 tons

New Rolling Stock for New Zealand Railways

The government of New Zealand has signed a contract with the North British Locomotive Company for the delivery of 25 Pacific type locomotives at a price of $43,225 each. The weight of the locomotives will be 190,000 lb. in working order. Cammell Laird & Co. have received the contract for the delivery of 2,500 eight-ton freight cars at a price of $1,139.75 per car. In addition to the above, there are under construction in New Zealand, by Price Brothers, Thames, 20 locomotives of the Pacific type, similar in every respect to those to be supplied by the North British; also, ten of the same type to be built in the government's own workshops. The government is now calling for bids for 1,000 additional freight cars to be built in New Zealand.

The Pullman Company Wage Reduction

Conflicting reports resulting from an account of a so-called voluntary wage cut of 20 per cent by employees of the Pullman Company at Chicago, have simmered down to two or three authoritative outstanding facts.

In the first place, the suggestion of a wage cut was made by J. B. Weaver, vice-president in charge of construction of the Pullman Company, who advised the employees at the Pullman Car Works, which is an open shop employing 9,000 men, that a decrease in their pay was necessary. The matter of reductions in pay at the Pullman repair shop, which is unionized, has not yet been brought up.

At present, the company is restoring its men at the Pullman repair shop to the basis of a nine-hour day, as against the eight-hour day under which they have been working. The nine-hour day will apply five days a week, with a five-hour day on Saturday.

MEETINGS AND CONVENTIONS

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associotions and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railway Association, Division V—Mechanical—V. R. Hawthorne, 431 South Dearborn St., Chicago. Next convention June 15-22, Atlantic City, N. J. Exhibit by Railway Supply Manufacturers' Association.

Division V.—Equipment Painting Division.—V. R. Hawthorne, Chicago.

American Railway Association, Division VI.—Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio. Second annual meeting June 20-22, Atlantic City, N. J.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamlin Ave., Chicago. Convention September 12, 13 and 14, Hotel Sherman, Chicago.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, O.

Association of Railway Electrical Engineers—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Meeting second Tuesday in each month except June, July and August, at Windsor Hotel, Montreal, Que.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago. Meeting second Monday in month, except June, July and August, New Morrison Hotel, Chicago.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

Central Railway Club.—H. D. Vought, 95 Liberty St., New York. Meeting second Thursday in January, March, May, September and November.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill. Next meeting March 3 and 4, 1921, Hotel Sherman, Chicago.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Next meeting February 8. Short addresses will be made by E. R. Oliven, G. F. A., Southern Railway; A. G. Olberding, American Brake Shoe Company, and R. C. Barnard, superintendent, Pennsylvania System. There will also be a musical entertainment.

Dixie Air Brake Club.—E. F. O'Connor, 10 West Grace St., Richmond, Va.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 715 Clarke Ave., Detroit, Mich. Next meeting, August 16, 17 and 18, 1921, Hotel Sherman, Chicago.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago. Next annual meeting, May, 1921, Hotel Sherman, Chicago.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn. Convention, September 12, 13, 14 and 15, 1921, Hotel Sherman, Chicago.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York. Convention, May 23 to 26, 1921, inclusive, Planters' Hotel, St. Louis, Mo.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting February 8. Paper on Problem of Handling Material and Freight on Railroads will be presented by Charles N. Winter, Associate Editor, *Railway Mechanical Engineer.*

New York Railroad Club.—H. D. Vought, 95 Liberty St., New York. Next meeting, February 18. Paper on Operating Problems will be presented by J. J. Mantell, manager, New York Region, Erie Railroad.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Building, Buffalo, N. Y. Regular meetings, January, March, May, September and October.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Meetings second Thursday in month, alternately in San Francisco and Oakland, Cal.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Meetings fourth Thursday in month except June, July and August, Americus Club House, Pittsburgh.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Meetings second Friday in month except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Buffalo, N. Y.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Next meeting, February 21. A paper on Modernizing Existing Locomotives will be presented by G. M. Basford.

PERSONAL MENTION

GENERAL

C. H. Temple, superintendent of motive power and car department of the Canadian Pacific, Western Lines, has been appointed chief of motive power and rolling stock, with headquarters at Montreal.

R, Preston, assistant superintendent of motive power of the Canadian Pacific, with headquarters at Winnipeg, Man., has been promoted to superintendent motive power and car department, Eastern Lines, with headquarters at Montreal.

W. L. Robinson, master mechanic of the Baltimore & Ohio, with headquarters at Washington, Ind., has been appointed superintendent fuel and locomotive performance, with headquarters at Baltimore Md., succeeding E. E. Ramey, who has been assigned to other duties.

H. H. Stephens, master mechanic of the Pecos division of the Atchison, Topeka & Santa Fe with headquarters at Clovis, N. M., has been promoted to mechanical superintendent of the Southern district with headquarters at Amarillo, Tex., succeeding W. D. Deveny, assigned to other duties. W. D. Hartley, general foreman, locomotive department, at Richmond, Cal., succeeds Mr. Stephens at Clovis.

R. A. Pyne, superintendent of the motive power and car department of the Canadian Pacific, Eastern Lines, with headquarters at Montreal, Que., has been transferred to Winnipeg, Man., succeeding C. H. Temple. A. Sturrock, master mechanic of the British Columbia district, with headquarters at Vancouver, B. C., has been promoted to assistant superintendent of motive power, with headquarters at Winnipeg, Man.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

J. W. Chandler has been appointed master mechanic of the Kansas City Southern, at Pittsburg, Kan., succeeding C. J. Burkholder, resigned to enter the service of another company. C. L Adair succeeds Mr. Chandler as master mechanic at Shreveport, La.


E. R. Woody

Edmund R. Woody, whose promotion to master mechanic on the Chesapeake & Ohio at Peru, Ind., was announced in the January issue, was born on September 10, 1880, at Richmond, Va. Mr. Woody entered the employ of the Chesapeake & Ohio on October 1, 1895, as a machinist apprentice and in 1900 was appointed erecting gang foreman. In 1909, he was transferred to the Newport News shops as assistant general foreman and in 1910 became general foreman at the Richmond Seventeenth street shops. In 1912 he was appointed assistant master mechanic in charge of the Fulton shops, Richmond, which position he held until his appointment as master mechanic at Peru.

Alexander Peers, who has been appointed master mechanic of the Canadian Pacific at Moose Jaw, Sask., Canada, was born in August, 1875, at Cheshire, England. Mr. Peers entered the service of the Canadian Pacific on July 16, 1901, at Winnipeg, as a machinist. From June 2, 1906, to June 12, 1906, he served as a draughtsman and from June 13, 1906, to August 6, 1906, served as relief locomotive foreman at Winnipeg, Fort William and Ignace. On August 7, 1906, he became locomotive foreman at

Souris, Brandon and Winnipeg. From April 24, 1914, until the time of his recent appointment, he was division master mechanic at Winnipeg and Moose Jaw.

G. M. Lawler, who has been appointed master mechanic on the Atchison, Topeka & Santa Fe at La Junta, Colo., as noted in the January issue, was born on July 12, 1888, at Albuquerque, N. M. Mr. Lawler attended a business college for two years at night and entered the employ of the Atchison, Topeka & Santa Fe as a machinist apprentice at Albuquerque on February 28, 1905. In 1910 he was promoted to gang foreman and in 1911 became roundhouse foreman. In 1914 he was transferred to Belen, N. M., as division foreman and in 1916 was transferred to Raton, N. M., as general roundhouse foreman, which position he held at the time of his recent appointment.


G. M. Lawler

CAR DEPARTMENT

W. J. Robider, general master car builder of the Canadian Pacific, has retired and the position has been abolished. The duties of general master car builder have been assumed by the assistant chief mechanical engineer.

SHOP AND ENGINEHOUSE

Ernest Ruick, a machinist, has been promoted to night roundhouse foreman of the Atchison, Topeka & Santa Fe at Strong City, Kan.

R. Tuck, roundhouse foreman of the Atchison, Topeka & Santa Fe at Richmond, Cal., has been transferred to Needles, Cal., as general foreman. E. F. Callaher, formerly roundhouse foreman at Richmond and transferred to Needles, has been returned to Richmond.

E. A. Murray, master mechanic of the Chesapeake & Ohio, with headquarters at Clifton Forge, Va., has been promoted to shop superintendent at Huntington, W. Va., succeeding H. M. Brown, resigned. C. B. Hitch succeeds Mr. Murray as master mechanic at Clifton Forge.

John Edward Garretson has been appointed general foreman on the Chesapeake & Ohio at Hinton, W. Va. Mr. Garretson was born on December 12, 1888, at Montgomery, W. Va. He attended the Hinton high school and in June, 1904, started to work as a call boy and a machinist's helper. In July, 1905, he entered the service of the Chesapeake & Ohio as a machinist apprentice at Hinton. After completing his apprenticeship, he worked as a machinist until 1912, when he was sent to Logan, W. Va. In May, 1914, he was promoted to day roundhouse foreman, and on December 1, 1916, became general foreman at Logan, which position he held until his recent appointment.

PURCHASING AND STOREKEEPING

Edmund T. Burnett has retired as general purchasing agent of the Norfolk & Western. Mr. Burnett was born in Philadelphia, Pa., and was educated at Saunders Institute. He was engaged in mercantile pursuits for several years after he had completed his schooling and first entered railway service in 1882 as chief clerk to the purchasing agent of the Norfolk & Western. In 1891 Mr. Burnett was appointed assistant purchasing agent, with headquarters at Roanoke, Va. In 1893 he was promoted to purchasing agent with headquarters at Philadelphia. When the road was reorganized in 1896 Mr. Burnett transferred his headquarters to Roanoke. When the government assumed the operation of the railroads Mr. Burnett was appointed, first, an associate member of the Eastern Regional Purchasing Committee and, later, regional purchasing agent for the Pocahontas region. When the roads were returned to their owners Mr. Burnett was appointed general purchasing agent of the Norfolk & Western.

SUPPLY TRADE NOTES

C. L. Mellor, manager of sales of the Barco Manufacturing Company, Chicago, has been elected secretary of this company. Mr. Mellor will continue his duties in charge of sales in addition to his duties as secretary.

John R. LeVally, formerly sales engineer of the Locomotive Superheater Company, at Chicago, has been appointed district sales manager of the company at Pittsburgh, Pa., with offices in the Union Arcade building.

Martin J. Root, formerly of the Fairbanks Company, New York, has been elected president of the United States High Speed Steel & Tool Corporation, which has been reorganized. The headquarters of the company are at 489 Fifth avenue, New York.

C. R. Weber has been elected treasurer of the Sherritt & Stoer Company, of Philadelphia, filling a vacancy made through the retirement of C. H. Stoer some time ago. Mr. Weber, previous to his appointment as treasurer, was in charge of the accounting department.

George S. Bigelow, formerly manager of the railway department of the Chicago Varnish Company, is now in charge of the railway department of the Mountain Varnish & Color Works, Inc., of Toledo, Ohio, with offices in the Railway Exchange building, Chicago.

Edmund H. Walker, first vice-president of the Standard Coupler Company, New York, has been elected president, succeeding George A. Post, who has retired. Mr. Walker has been connected with the company since February, 1905. Previous to his connection with the Standard Coupler Company he was engaged in railroad work with the Great Northern, the Atchison, Topeka & Santa Fe, the Chicago, Burlington & Quincy, and the Minneapolis, St. Paul & Sault Ste. Marie, in various departments. Mr. Walker has taken an active part in the work of the Railway Supply Manufacturers' Association and was three times elected president of the organization, serving in that capacity during the years 1917, 1918 and 1919.


E. H. Walker

C. E. Adams, vice-president of the Air Reduction Sales Company, New York, has been elected president to succeed A. F. Blagden, who has resigned to become associated with the American Dyewood Company, New York. John McHugh has been elected a director to succeed H. R. Hoyt, deceased.

The Hallidie Machinery Company, L. C. Smith building, Seattle, Wash., have been appointed representatives of the Conveyors Corporation of America, Chicago, formerly the American Steam Conveyor Corporation. They will handle the sales of the American steam conveyor and American trolley carrier in the states of Washington and Oregon.

The Whiting Foundry Equipment Company, Harvey, Ill., has announced that it has changed its name to the Whiting Corporation, increasing its authorized capital stock from $700,000 to $3,000,000. The Whiting Corporation remains under the same management and will continue the manufacture of cranes, foundry equipment and railway specialties as heretofore.

The Reade Manufacturing Company has moved from Hoboken, N. J., into its new factory at Jersey City, N. J., where additional facilities are available. Two new departments, a traffic department and a mechanical or service department, have been added to the organization, both of which are under the supervision of R. H. Vogle, sales manager of the railroad department.

At the annual election of the Union Railway Equipment Company, Chicago, the following officers were elected: W. B. Hall, president and treasurer; G. W. Clark, controller and secretary; A. F. O'Connor, mechanical engineer; E. S. Jubell, superintendent; H. O. Comstock, sales agent. Mr. Jubell was formerly in charge of the forge department for the Haskell & Barker Car Company. The company's new forging plant, located on the Indiana Harbor Belt, at Hammond, Ind., is now in operation.

R. W. Levenhagen, secretary of the Sherwin-Williams Company, Cleveland, Ohio, has been elected vice-president in charge of auxiliaries of the Glidden Company, Cleveland. Mr. Levenhagen has spent the greater part of his life in the paint and varnish industry, having started with the Sherwin-Williams Company 25 years ago. He held various positions in the service of the Sherwin-Williams Company and rose steadily until he became secretary, which position he held until his recent election as vice-president of the Glidden Company. Besides serving as secretary of the Sherwin-Williams Company, he was vice-president and general manager of the Detroit White Lead Works, Detroit, Mich., and vice-president of the Martin-Senour Company, Chicago, for a number of years.

Joseph Sinkler has resigned his position with the Franklin Railway Supply Company, Inc., to become general manager of the railway division of the Pilot Packing Company, Inc., with headquarters in the Peoples Gas building, Chicago, Ill. Mr. Sinkler was born at Scranton, Pa., and began his business life with the Dickson Locomotive Works in the same city. Three years later he entered the employ of the New York, Susquehanna & Western and the Delaware, Lackawanna & Western. On July 1, 1904, he became associated with the Franklin Railway Supply Company, and on January 1, 1916, was appointed western representative of the Economy Devices Corporation, Chicago. Resigning from this position on November 15, 1917, he accepted a position as special representative of the Perolin Railway Service Company, and on January 1, 1919, returned to the services of the Franklin Railway Supply Company, where he remained until his present appointment.

J. Sinkler

Howard C. Mull, manager of the sales department of the Verona Tool Works, Pittsburgh, Pa., with headquarters at Chicago, has been appointed manager of the railway department of the Reliance Manufacturing Company, of Massillon, Ohio, with offices at Chicago. Mr. Mull was born on July 13, 1889, at Cincinnati, Ohio, and entered railway service in the engineering department of the Cleveland, Cincinnati, Chicago & St. Louis in 1910. Two years later he was transferred to Cleveland, Ohio, and placed in charge of safety matters. In May, 1913, he entered the employ of the Verona Tool Works, and two years later was promoted to representative of sales, western territory, with headquarters at Chicago. In 1918 he was appointed manager of sales, with headquarters at Chicago, the position he occupied at the time of his recent appointment.

On January 1 the Chambers Valve Company, Inc., New York, was taken over by the Bradford Draft Gear Company, with offices at 23 West Forty-third street, New York; Munsey building, Washington, D. C., and McCormick building, Chicago. Frank H. Clark, formerly president of the Chambers Valve Company, becomes vice-president of the Bradford Draft Gear Company, with headquarters at New York, while the Washington office will be under the direction of Harry F. Lowman, vice-president.

R. F. Eissler has been appointed assistant to the vice-president of the Chicago Pneumatic Tool Company, New York, with headquarters in the company's new office building at 6 East Forty-fourth street, New York. W. C. Straub, formerly district manager of the New Orleans branch, has been appointed district manager of the Pittsburgh branch to succeed Mr. Eissler, and Ross Wyeth, formerly attached to the Pittsburgh branch, has been appointed district manager of the New Orleans branch to succeed Mr. Straub.

A. D. Graves, manager trade sales of Pratt & Lambert, Inc., Buffalo, N. Y., has been appointed general manager of the company. This position was formerly held by President J. H. McNulty. C. D. Sproule, sales manager, western division, at Chicago, has been appointed resident manager with office at Chicago. J. R. Mickle, railway sales representative at New York, has been appointed sales manager at New York, and H. M. Guisey, assistant resident manager at Buffalo, has been appointed assistant sales manager at New York. The company held a convention from January 10 to 13 in a publicity building which it has recently completed in Buffalo, N. Y. At this meeting there were a number of interesting addresses made by officers of the company and many papers were presented by the salesmen.

A. D. Graves

Mr. Graves is a native of Ohio, his boyhood having been spent in Columbus. He was a bookkeeper in a wholesale drygoods house for nearly five years previous to entering the employ of a concern manufacturing varnish. In 1908, he started as a salesman for Pratt & Lambert and spent the next ten years in developing trade in Philadelphia and vicinity, when he became manager trade sales. Mr. Graves is one of the successful twelve Pratt & Lambert men whose high percentage of sales won them a trip to Europe in the summer of 1914.

Harry R. Warnock, vice-president in charge of mechanical matters of the Standard Stoker Company, New York, and formerly general superintendent of motive power on the Chicago, Milwaukee & St. Paul, died suddenly of heart failure at Hagerstown, Md., on January 19. He was born at Newcastle, Pa., on July 16, 1870. He began railway work as a freight brakeman with the Pennsylvania Lines West of Pittsburgh in June, 1889, and in the same year went to the Pittsburgh & Lake Erie as a brakeman. In September, 1891, he was promoted to locomotive fireman and later was locomotive engineer, which position he held until May, 1900. From that date until July, 1904, he served consecutively as engine despatcher, roundhouse foreman and general foreman, resigning on the latter date to become master mechanic of the West Side Belt, Pittsburgh, Pa., where he remained until October, 1905, when he became master mechanic of the Monongahela Railroad. He remained in this position until September, 1913, when he was appointed superintendent of motive power of the Western Maryland, which

H. R. Warnock

position he held until December 15, 1917, when he was appointed general superintendent of motive power of the Chicago, Milwaukee & St. Paul. In July, 1920, he became associated with the Standard Stoker Company and at the time of his death was vice-president in charge of mechanical matters, as above noted.


E. W. Englebright

E. W. Englebright, who was engineer for the New York office of the Union Pacific until that office was merged recently with the organization of the assistant to the president at Omaha, Neb., where he has been located since that time, has resigned to become associated with the Elvin Mechanical Stoker Company, 50 Church street, New York. Mr. Englebright was born on January 12, 1885, at Oakland, Cal., and attended public schools until 1903 He then entered the employ of the Southern Pacific at Oakland, Cal., in its engineering department and served as rodman, levelman and transitman until 1905, when he entered the University of California, pursuing a course of civil engineer- until 1909. He then returned to the Southern Pacific and served as assistant engineer on the Shasta division at Dunsmuir, Cal., until 1910, when he was appointed assistant division engineer. In 1912 he served as roadmaster at Klamath Falls, Ore., remaining there until 1913, when he became assistant to E. E. Adams, then consulting engineer of the Union Pacific System for engineering, motive power and equipment standards, with headquarters at New York. Following the appointment, in 1918, of Mr. Adams as engineer for the Division of Capital Expenditures, at Washington, Mr. Englebright was appointed acting consulting engineer for the Union Pacific System corporations, with the added duties of purchasing the large number of locomotives and cars, orders for which were placed by the Union Pacific System prior to the termination of federal control. On the return of the railroads to private control he became engineer for the New York offices of the Union Pacific System, as noted above.


H. H. Marsh

Howard H. Marsh, for nearly eight years district manager of the *Railway Mechanical Engineer*, and the other publications of the Simmons-Boardman Publishing Company, at Cleveland, Ohio, has resigned to become president of the Victory Equipment Company, with office at 444 Maison Blanche Annex, New Orleans, La. As head of the Victory Equipment Company, he will handle the following accounts: McMyler-Interstate Company, Cleveland, locomotive cranes, pile drivers and material handling equipment; Ball Engine Company, Erie, Pa., steam shovels and railroad ditchers; Schaefer Equipment Company, Pittsburgh, Pa., truck lever connections, brake levers, brake rod jaws and stake pockets; and Equipment Manufacturing Company, Cleveland, trucks and trailers.

His education, business experience and wide acquaintance fit Mr. Marsh for his new undertaking. He is still a young man, having graduated at the University of Vermont in 1903, with the degree of B.S. in civil engineering. That same year he entered the employ of Engineering News (now Engineering News-Record), as assistant to the western manager, and stayed there until 1907, when he was appointed western representative of Engineering-Contracting, with headquarters in Chicago. He left the latter place to go to Cleveland as district manager of the Simmons-Boardman Publishing Company. Mr. Marsh's removal to New Orleans is due to his desire to be near his family, as it was necessary for Mrs. Marsh to take up her residence in the Southwest in order that her health might be restored. In addition to his other work, Mr. Marsh will continue to act as representative of the Simmons-Boardman Publishing Company in the southwestern territory.

D. E. Sawyer has been re-elected general sales manager of the Pollak Steel Company, Cincinnati, Ohio, with office at 120 Broadway, New York; S. K. Morrow, manager of operations, has been appointed manager of sales for its three plants, with office at the Cincinnati works; C. G. Talbott, assistant manager of operations, has been appointed manager of rolled products for the Marion plant; A. C. Weihl, superintendent of the Cincinnati plant, has been appointed general works manager in charge of operations and productions of the Cincinnati, the Chicago and the Marion plants, and V. W. Prather, cost auditor for the Cincinnati plant, has been appointed auditor of the three plants. R. A. Mitchell has succeeded Mr. Weihl as superintendent of the Cincinnati plant; J. H. Deickman has been appointed manager of materials and inspection of its three plants; W. P. Woods has been appointed auditor, and G. H. Tallaksen, superintendent of the Chicago plant. The company has recently distributed a unique souvenir; it is a pen made in the form of a miniature standard M. C. B. car axle, with machined wheel seat and journal and rough turned center.

Lima Locomotive Works Changes

Lewis A. Larsen, assistant to the president of the Lima Locomotive Works, Inc., has been elected vice-president and Waldo H. Marshall has been elected a director.


L. A. Larsen

Mr. Marshall was formerly president of the American Locomotive Company and later resigned to go with J. P. Morgan & Co.

Mr. Larsen was born at Ridgeway, Ia., in 1875. He received his early education in the public schools of Ridgeway and Decorah, Ia., and Upper Iowa University, Northwestern University and St. Paul College of Law. In November, 1897, he entered the service of the Chicago Great Western as clerk to the master mechanic. He held successively the position of chief clerk to the superintendent of motive power and chief clerk to the assistant general manager. In 1904 he resigned to accept the position of chief clerk to the superintendent of motive power of the Northern Pacific at St. Paul. In November, 1906, he became associated with W. H. S. Wright, railway supplies, representing the Railway Steel Spring Company, the Pittsburgh Forge & Iron Company and other companies, and in 1907 entered the service of the American Locomotive Company. In 1909 he was appointed assistant to the vice-president in charge of manufacturing, and July, 1917, was appointed assistant controller. For several years previous to 1917 Mr. Larsen was a special lecturer in the Alexander Hamilton Institute, New York. He has also contributed a number of papers to the railroad magazines. In December, 1917, he was appointed assistant to the president of the Lima Locomotive Works.

Millholland Sales and Engineering Company

W. K. Millholland and E. Millholland have sold out one part of their interest in the Millholland Machine Company and have started a new company, called the Millholland Sales and Engineering Company, with temporary offices at 304 Rauh building, Indianapolis, Ind. After March 1 the company will occupy the machinery store which Marshall & Huschuert have been occupying. This new company will handle a line of railroad and machine shop equipment, and also foundry equipment, and act as consulting engineers on manufacturing and designing problems.

W. K. Millholland, for the past six years president and general manager of the W. K. Millholland Machine Company, previous to taking over active management of the Millholland company, was sales engineer for several large machine tool companies, and also designer for a machine tool company. He is a member of the American Society of Mechanical Engineers.

E. Millholland has for the past ten years been vice-president and works manager of the Millholland Machine Company. During the past three years he was also sales engineer.

The Foote-Burt Company Completes New Plant

The Foote-Burt Company, Cleveland, Ohio, has recently completed a new plant at East One Hundred and Thirty-first street and St. Clair avenue, which increases considerably the company's manufacturing facilities. The total floor area of the new shop is over 131,000 sq. ft. The main factory building is of brick, concrete and steel construction, 507 ft. by 236 ft., exclusive of the addition which houses the shipping department. Separate buildings are provided for the boiler house and for chip storage.

The equipment in the main building is arranged for progressive manufacturing. All material is received in the rear main aisle and is distributed from this aisle to the manufacturing department in the center of the building. The parts move to the front main aisle from which they are distributed to the assembling department in the front of the building. By means of a monorail system, the completed machines are taken from the assembling department to the shipping department. The general offices are on the ground floor across the front of the building, with the factory office on the west side, adjacent to the dispensary and experimental department. A notable feature of the plant is the drawing room, which covers the entire second story of the front end of the building and is approximately 235 ft. long by 24 ft. wide.

American Brake Shoe & Foundry Company

William F. Cutler, president of the Southern Wheel Company, St. Louis, Mo., has been elected vice-president of the American Brake Shoe & Foundry Company, with headquarters at New York, and William B. Given, Jr.. assistant vice-president at New York, has also been elected a vice-president.

William F. Cutler was born on March 5, 1888, at Washington, D. C., and was educated at Hill School, Pottstown, Pa., and was in the class of 1909, at Sheffield Scientific School, Yale University. He began railway work as an apprentice in the Altoona (Pa.) shops of the Pennsylvania Railroad, and later served in the shops of the Hale & Kilburn Company, Philadelphia, Pa. In 1912 he entered the service of the American Brake Shoe & Foundry Company at New York, and subsequently held various positions until 1914, when he went to St. Louis as vice-president of the Southern Wheel Company, a subsidiary of the American Brake Shoe & Foundry Company. In 1917 he was elected president of the Southern Wheel Company, which position he still retains, in addition to his new position as vice-president of the American Brake Shoe & Foundry Company. He is a son of Otis H. Cutler, chairman of the board of the American Brake Shoe & Foundry Company.

William B. Given, Jr., was born on December 7, 1886, at Columbia, Pa., and was educated at Yale University. He has been in the service of the American Brake Shoe & Foundry Company since 1911, with the exception of two years, when he served in the United States Army. He held various positions with the American Brake Shoe & Foundry Company until 1915, when he was appointed assistant to president. From May, 1917, to May, 1919, he served as a captain of infantry in the Rainbow Division of the United States Army, and then returned to the American Brake Shoe & Foundry Company as assistant vice-president, which position he held until his recent election as vice-president of the same company as above noted.

TRADE PUBLICATIONS

Heaters.—The Ross Heater & Manufacturing Co., Inc., Buffalo, N. Y., has issued a 39-page book, Catalogue F, which illustrates and describes the various types of heaters, condensers, expansion joints, coolers and air-jector pumps which it manufactures.

Ladles.—The Whiting Corporation, Harvey, Ill., has issued catalogue No. 156 descriptive of their complete line of foundry ladles, including their new style helical worm geared crane ladle and a new style teapot spout ladle, having the spout inside of the bowl. The book is well illustrated.

Iron.—The Burden Iron Company at Troy, N. Y., have just issued a 30-page catalogue describing Burden iron products and their use in the railroad field. Clear cut illustrations show the various processes through which all Burden products must pass and particular attention has been given to various uses in locomotive and car construction. The booklet is well illustrated and very carefully written.

Riveting Machines.—Catalogue No. 4, entitled "Riveters," has been issued by the Hanna Engineering Works, Chicago, and includes 63 pages devoted to the description and illustration of various types of riveting machines. These machines include the common types of gap riveter, the boiler door ring riveter, pinch bug riveter, combination yoke riveter, forged nose riveter, boiler head riveter and others.

Radial Drills.—An unusually well illustrated and carefully prepared catalogue has been issued by the Western Machine Tool Works, Holland, Mich., devoted to a description of the Western low hung drive plain radial drill, designed for heavy duty. A general description and illustration of the machine is given in the front of the catalogue, accompanied by diagrams of the driving mechanism. A description also is included of a special tilting table.

The Melting Pot.—A monthly publication, known as The Melting Pot, containing much timely information regarding heat treatment, together with descriptions and illustrations of the use of Stewart furnaces, is being issued by the Chicago Flexible Shaft Company, Chicago. A large amount of information on annealing, carburizing and other heat treating subjects is included. In addition, there are many up-to-date and valuable notes on shop practice, particularly relating to heat treatment.

Screw and Ratchet Jacks.—The complete line of jacks made by the Duff Manufacturing Company, Pittsburgh, Pa., is described and illustrated in catalogue No. 104. Jacks of similar construction are grouped and a general description of the construction and operation is given, which is followed by a few short notes on the particular service for which each special type is best fitted. In the closing pages of the catalogue are shown illustrations of repair parts and tables to facilitate ordering material needed for repairs.

Vertical Surface Grinders.—A 40-page catalogue has been issued by the Blanchard Machine Company, Cambridge, Mass., containing in the foreword an interesting description of the development of the Blanchard vertical surface grinder. Illustrations are given showing the rigid construction and power of the machine. Special attention is called to the wheel mounting, spindle arrangement and direct motor drive; also the magnetic chuck. The reading pages of the catalogue are devoted to a description of the field for vertical surface grinding and the advantages of this method of machining are pointed out.

Lathe Chucks.—The 1921 catalogue of the Cushman Chuck Company, Hartford, Conn., is now ready for distribution and contains 50 pages, entirely rewritten and rearranged. Illustrations show the original Cushman workshop and the present plant. Each general style of chuck is fully described, and sizes and prices, together with code words, are quoted. Line drawings and tables also show the dimensions of detailed parts of the chuck. Useful information furnished in this catalogue includes directions for increasing the efficiency of lathe chucks, prolonging their life and instructions regarding the repair and replacement of parts.

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Volume 95 March, 1921 No. 3

CONTENTS

EDITORIALS:
An Incentive to Provide for Car Maintenance.................. 143
The Foreman a Business Man.................. 143
Are Diesel Locomotives a Possibility?.................. 144
The Effect of a Seniority Ruling.................. 144
Railroad Administration Draft Gear Tests.................. 144
Equalization of Weights on Locomotive Wheels.................. 145
Why Build Firing-Up Sheds?.................. 145

COMMUNICATIONS:
Straight vs. Coned Treads for Driving Wheels.................. 145
Ball Bearings for Railway Cars.................. 146
New Books 146

GENERAL:
Mountain Type Features New Rock Island Power.................. 147
Getting Better Results from Railroad Organizations.................. 151
Reducing the Fuel Consumption of Power Plants.................. 154
The Diesel Engine in Railroad Service.................. 156
Controversy Before Labor Board Continues.................. 160
Fatal Gasoline Explosion at Memphis.................. 162

CAR DEPARTMENT:
120-Ton Cars Now in Service on the Virginian.................. 163
Tank Car Outlets and Other Projections.................. 170
Effect on Cost of Repairs of Changes in the Percentage of Freight Cars at Home.................. 170
Container Car in Express Service on N. Y. C. Lines.................. 171
Draft Gear Tests of the Railroad Administration.................. 173

SHOP PRACTICE:
Application of Limit Gages and Progressive Sizes in Railway Macbine Shops.................. 177
Driving Box Gage.................. 178
Notes on General Shop Practice at Du Bois.................. 179
Chuck for Holding Hose Nuts.................. 181
Instructions for Grinding Chilled Cast Iron Car Wheels.................. 181
Reaming Reversing Valve Bushings.................. 184
Liberty Flue Cutter 184
Emergency Seat Refacing Tool.................. 184
A Profitable Railroad Reclamation Project.................. 185
Easily Made Spring Bander.................. 187
Crosshead Babbitting Devices Eliminate Machining.................. 187
Method for Squaring Walschaert Valve Gear.................. 189
The Effect of Relative Humidity on Leather Belting.................. 190
An Air Compressor Repair.................. 191
Locomotive Cylinder Welding.................. 191
Driving Box Grooving Device.................. 192

NEW DEVICES:
Small High Duty Surface Grinder.................. 193
Regulating Valve for Liquid Fuels.................. 194
Duplex Mono Flue Gas Analyzer.................. 195
Safety Locomotive Cold Water Sprinkler.................. 196
A Long Life Cutting-Off Tool.................. 196
Centrifugal Pump for Cooling Compounds.................. 197
Precise Parallel Ruling Attachment.................. 197
Vertical Spindle Surface Grinding Machine.................. 198
Pilot Bar and Drill Press Chucks.................. 198
Die Heads for Railroad Shop Use.................. 199
Self-Contained Internal Grinder.................. 200
A Handy Forge for Heating Rivets.................. 200
Radial Drill Stand and Removable Drill.................. 201
Helical Worm-Geared Crane Ladle.................. 201

GENERAL NEWS:
Notes 202
Meetings and Conventions 203
Personal Mention 203
Supply Trade Notes 204
Trade Publications 206

An Incentive to Provide for Car Maintenance

A study of the probable effects of the adoption as a permanent policy of a scale of prices for labor and material expended in the maintenance of foreign freight cars in interchange, high enough to include a profit, reveals a wide range of possibilities, the ultimate result of which will all tend toward cheaper maintenance of equipment. One of the difficulties in the way of adequate maintenance of freight car equipment under heavy traffic conditions—when a large part of the work must be done—is the lack of adequate facilities. It is true that many railroads are adequately supplied with such facilities and it is only because of this fact that other railroads can continue to operate without making provision for the full share of repairs which the volume of their traffic should bear. For such roads there is little incentive to make the improvements needed so long as to the well equipped roads may be left a considerable measure of the responsibility for taking care of the equipment of the country, when it costs the poorly equipped roads less to pay for the work at M. C. B. rates than to do it themselves. The prices fixed at the present time are high enough to show a profit for those roads whose costs are considerably below the average. But if they were fixed with the deliberate intent of including an average profit of 10 or 15 per cent above the actual cost of labor, material and overhead, would there not be created a powerful incentive for those roads whose costs are high because of a lack of adequate modern facilities, to provide the needed facilities? Is it not reasonable to suppose that, once provided, these facilities would fully justify themselves by the reduction in unit costs, the immediate benefit of which would accrue to the roads making such investments?

The Foreman a Business Man

The lack of training which foremen are given to fit them for their responsibilities as leaders of men was forcefully brought to attention by G. M. Basford's paper before the February meeting of the Western Railway Club. Leadership is probably the most important function of the foreman, but the variety of ability and capacities the possession of which are advantageous both to the foreman and to the railroads, is almost endless. There are others than that of leadership which ought to be developed by training. One of these is the ability to visualize the job of running a shop or a roundhouse as a part of the business of furnishing transportation, in which money is spent to get certain results; and the ability to see the part these results play in the production and the cost of train miles. Conditions are such at the present time that the problem of leadership is paramount and it must be solved if satisfactory relationships are to be re-established on the railroads. The very necessity for concentrating on this one problem, however, entails the danger of a loss of breadth of view leading to the neglect of other factors affecting the cost of equipment maintenance and operation. Not only is it necessary to get production from labor, but it is necessary to take advantage of every device or plan whereby the need for depending on labor may be eliminated. Sometimes these things are beyond the authority of the foreman because of the capital investment involved. But the ability of the foreman on the ground to see the possibilities, even though his authority will not permit him to go ahead independently, is an asset the railroad should cultivate. A recommendation for many improvements of this nature must originate with the foremen and if the dollars and cents aspect—the business aspect—can be presented along with the more tangible advantages of convenience, an invaluable service has been rendered to the head of the department. Too frequently, however, when such ability shows itself among the foremen its exercise is discouraged, if not suppressed, by the executive officers of the department and until these officers not only learn to recognize its value but develop it themselves, it is unfair to expect much from the foremen.

Are Diesel Locomotives A Possibility?

Anyone reading the article regarding the Diesel engine in railroad service, which appears in this issue, cannot fail but be impressed with the prominent role this development has assumed in Sweden and with some of the claims advanced for the Diesel engine as a source of motive power in heavy traction. While the advocates of the oil engine are not laboring under any delusion as to the prospect of any immediate use of the Diesel motor in heavy traction, it is felt that as our higher grade fuel resources approach exhaustion the economic pressure upon large fuel users will be so great as to force the adoption of a more economical prime mover. It is argued that this applies with particular force to the railroads since they are the largest consumers of high grade fuels and are already feeling acutely the great increase in cost. While current fuel prices are expected to decline, no return to the prewar levels is anticipated, and there is bound to be a gradual appreciation in the price of any commodity as its supply diminishes. Sooner or later the law of supply and demand is going to work some tremendous changes in the conduct of our railroads. Just as we now realize that the railroads could not have held up under the war strain had it not been for other appliances contributing to the economy of the modern locomotive, so the day will come when some of the refinements that we are now reluctant or afraid to adopt will be regarded as equally vital. If electric traction is some day to figure prominently on railroads of dense traffic, is it altogether rash to predict the advent of the Diesel locomotive in sparsely populated districts remote from fuel producing centers? The Diesel engine underwent a remarkable development in submarine service during the war, and it is claimed that German manufacturers are now perfecting a transmission mechanism which will make it possible to use the same design Diesel motor in rail traction.

The Effect of a Seniority Ruling

The mutual welfare of railroad owners, managers, shop executives and shop employees is dependent on a just and common sense method of settling present disputed questions. It is impossible for one class to profit long at the expense of another and the best interests of all will be served by the early establishment of fair working conditions. One question about which there has been a wide diversity of opinion has been the rights of a workman due to his seniority or length of service. There can be no question but that in certain instances a seniority ruling will prevent injustice should there be partiality on the part of a foreman or should a man's ability for some reason be unknown. In by far the larger number of cases, however, experience has demonstrated that seniority does more harm than good, particularly as it prevents ambitious workmen from securing justified advancement. Moreover, the effect of this ruling is to encourage shiftlessness on the part of indifferent workmen who realize that they will be advanced according to length of service and irrespective of whether they turn out a fair day's work or not. This results in a decrease in shop production which is hard to estimate.

Another serious effect of the seniority ruling and one which should cause its abolition is the fact that a shop man may be allowed to try for a position for which he is entirely unfitted simply because he is the oldest man in length of service. A most forceful example of this occurred recently in a railroad shop where a young machinist, who had become thoroughly familiar with the operation of a piston rod grinding machine, was displaced by an older man who knew nothing about the machine. According to the National Agreement, the older man had three weeks in which to make good and for two weeks he struggled along with the machine. Production practically stopped and finally, lack of attention to lubrication caused the grinding wheel spindle bearings to melt and put the machine entirely out of commission. Men should not be tried out on work for which they are obviously unfitted and thoughtful shop workers, as well as managers, must realize that in the long run every one loses as the result of such wasteful practices.

Railroad Administration Draft Gear Tests

In this issue of the *Railway Mechanical Engineer,* there appears the first installment of a series of articles describing the tests of draft gears conducted by the Inspection and Test Section of the Railroad Administration. To those who have sought in vain for definite information among the many conflicting statements regarding draft gear performance that have been published in the past, these tests will be of incalculable value. The scope of the tests and the field of investigation remaining to be covered cannot be set forth more clearly than is done in the preface to the report by C. B. Young, under whose direction the work was conducted. In his introduction, Mr. Young states that when the Railroad Administration decided to build the standardized equipment, the Committee on Standards and the Purchasing Section were both embarrassed owing to a lack of definite and intelligent knowledge of the relative merits of the different gears as well as the relation between mechanical value and cost. Much information on the subject of draft gears was presented by the various manufacturers, but a comparison of the information offered soon developed the fact that each manufacturer had prepared his information on a basis of his own intellect, and that it was impossible to correlate or co-ordinate the various tests in any comparable manner. In the absence of definite information, the rivet shearing test was adopted, but results showed that the requirements of this specification were useless in judging the merits of the gears. The Inspection and Test Section was therefore requested to conduct a series of tests to determine the mechanical value of each make and type of friction draft gear then regularly offered for sale and these investigations are described in the report.

The information covering the tests which have been made on new gears is definite and final. To a limited degree, tests were made on gears which have seen considerable service, but the service tests and the train operation tests which the section had planned were not made because of lack of time. As Mr. Young points out, the report must be used as a whole in order to obtain accurate and definite information concerning the draft gear. The picking out and exploiting of an idea here or there which favors one or the other of the draft gears tested, is to be discouraged and those who use the report should guard themselves against errors of this kind. The report gives reliable, entirely comparable and unbiased values for new commercial gears of the various types and the values given should supplant the widely varying figures frequently given out in the past as a result of inaccurate, unscientific or incomparable tests.

Equalization of Weights on Locomotive Wheels

Locomotives built in recent years have usually been designed to carry loads on the driving wheels that are near the limit that the rails will bear. Furthermore, the heavy reciprocating parts add to the weight of the counterbalance and make the additional force due to the dynamic augment very great. The result is that heavy motive power imposes severe stresses on the track and lately there has been much discussion as to whether the loads are now greater than the track structure can withstand. Whether this is the case or not, it is certain that nothing should be done to increase the load on any of the wheels above its normal amount. Nevertheless this often occurs through improper distribution of the weights between wheels, either equalized together or in separate equalizing systems. Sometimes it is due to improper location of fulcrum pins or to reversing equalizers; in other cases the cause is not apparent. If locomotives were not designed with a high factor of safety, improper weight distribution would cause the overloaded parts to fail. Even if immediate failure does not occur, faulty equalization often causes much trouble. Hot bearings, broken springs and similar defects may be due to this condition when the cause is not suspected. If the weight on the leading truck or the front drivers is too low, these wheels may have a tendency to climb the rail. This is a troublesome feature of some designs of passenger engines.

To remedy the faulty conditions mentioned, the erection of the equalizing system should be done with care and the parts should be made to check with the blue print before they are applied. Even when this precaution is observed, some engines may leave the shop with the weight unequally distributed and for that reason scales for ascertaining the weight carried on each wheel should form part of the equipment of every large repair shop.

Why Build Firing-Up Sheds?

The judgment of master mechanics and shop superintendents in northern sections of the country who have taken the precaution to construct firing-up sheds for the protection of workmen while putting the finishing touches on locomotives just out of shops, was vindicated by the record-breaking snowfall in the latter part of February. There are almost always small, unfinished jobs to be done on locomotives when they leave the erecting pits, and in any case the trial runs develop work which must be done. The difficulty of getting mechanics and helpers to work effectively when exposed to severe or inclement weather and the resultant locomotive delays make some form of shelter necessary. Handling the work in the main shop is certain to hamper other operations. Some form of covered firing-up shed should be constructed in sections of the country subject to severe cold weather and provided with suitable heating and lighting arrangements. A steam line for blowers and an air line for pneumatic tools should be provided. In many cases it would also be advisable to have pits, inasmuch as these will greatly facilitate final inspection and repair work. In an actual case the cost of such a shed, substantially constructed, was only $3,500. This shed was large enough for a shop turning out not more than two locomotives a day. The interest at 6 per cent on $3,500 is $210, which represents the carrying charge on this investment. It is true that such a shed would not ordinarily be used more than half of the year, but it is equally evident that the saving due to accelerated locomotive movements and labor saving in even two or three spells of bad weather would more than equal the interest on the investment.

COMMUNICATIONS

Straight vs. Coned Treads for Driving Wheels

New York.

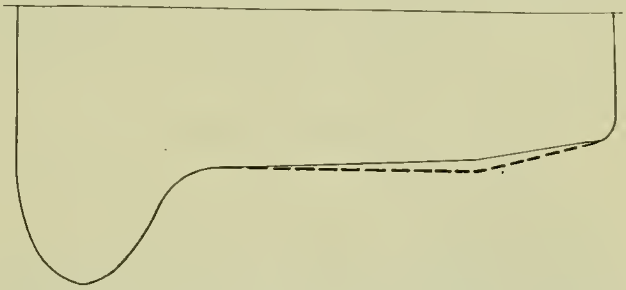
To the Editor:

The editorial relative to Sharp Tire Flanges in your issue of February, 1921, suggests the question: Why use cone-tread wheels in rigid wheel bases comprising two or more pairs of coupled wheels? The writer doubts the advisability of this practice under any circumstances other than with a single pair of wheels on a radial axle and is convinced that it is largely responsible for sharp flanges and poor tracking qualities.

Assume, for illustration, a locomotive with five pairs of coupled wheels and a rigid wheel base of 22 ft., with no provision for lateral movement other than 1/4 in. narrow tire setting on front and back wheels and the usual 1/4 in. total lateral play between wheel hubs and boxes, under which condition the maximum possible variation of alignment of flanges, is 1/4 in. between front and main, and main and back wheels. This is common practice on locomotives of the 2-10-2 type designed to traverse curves of 16 deg. deflection and a radius of 359 ft.

The middle ordinate of this curve on a 22 ft. chord is 2.02 in. and the quarter ordinates 1.51 in. Assuming the frames to be rigid the track must be laid 1.77 in. wider than standard gage to allow this locomotive to pass.

It may be seen that with the flanges of the front and back wheels in contact with the outer rail of this curve, those of the intermediate wheels will be 1.51 in. away from the outer rail and that of the main wheel will be 1.77 in. away from the outer rail.


Present Standard Tire Contour and Form Proposed for Driving Wheels

The taper of the tread of the American Railway Association standard tire section is 1 in 20, and the diameter changes 1/10 in. for each inch of tread. Thus it may be seen that the diameter of the intermediate wheels which run upon the outer rail are .151 in. (nearly 5/32) less than those of their mates which run upon the inner or shorter rail, while the diameter of the main wheel which runs upon the outer rail is .177 in., (over 11/64) less than that of its mate, which runs upon the inner or shorter rail. This condition of the smaller of pairs of wheels running upon the outer or longer rail is undoubtedly incorrect and just how much the lateral thrust of the front and back flanges is increased by the tendency of the intermediates to run toward the outer rail, over the pressure which would be had with wheels having straight treads, is very hard to estimate in view of varying conditions of rails, the use of sand, etc. It must be considerable, however, and no doubt causes more rapid flange wear than would be had with the straight treads.

It would seem that the use of tires with straight or parallel treads as shown in dotted lines on the accompanying diagram, on all wheels, would result beneficially. A good compromise would be to use A.R.A. treads on the front and back wheels and straight treads on all intermediates, although there are good and valid objections to this, as will be shown.

With cone-tread wheels on the wide gage track of sharp curves good flange lubrication is imperative and if cone treads must be used, it would appear that decided advantages would accrue from the use of some device which would allow lateral displacement of all but the main wheels, without sacrifice of stability. This applies not only to locomotives of the 2-10-2 type, but as well to any having coupled wheels.

Such a device should have only sufficient lateral resistance to permit the wheels to adjust themselves to any curve, which generally speaking, will be sufficient to return the wheels to the normal position on straight track and maintain stability in that position.

It is a well known fact that cone-tread wheels, when leaving the wide gage track of curves will seek to adjust themselves to correct diameters for straight track. In doing this several sidewise oscillations take place until the wheels find the true position. These oscillations have been known to spread the rails of poorly spiked and braced track, thereby causing derailments.

With coupled wheels of different diameters in the same wheel base on curves, some of the wheels must be slipped into correct relationship by the side rods. This no doubt causes rapid wear of rod bushings. With straight treads all diameters are alike and the only slipping necessary would be that due to the length of the rails traversed; this would produce only torsional stresses in the axles, which would not be detrimental to the rods.

While it is admitted that the cone tread is correct with one pair of wheels, it is herein suggested that straight treads have decided advantages in rigid wheel bases with coupled wheels. Chas F. Prescott.

Ball Bearings for Railway Cars

New York, N. Y.

To the Editor:

In the article on the use of ball bearings for railway cars, published on page 23 of the issue for January, 1921, there appeared a misleading statement, which I should like to have an opportunity to correct. The ball bearings on the Swedish State Railways, which were stated to have covered 240,000 kilometers and more, were repaired several times so that it was not really the same bearing which covered the total distance. This is best borne out by the fact that the Swedish State Railways have not made any further installations of ball bearings on passenger cars, but, on the other hand, have practically abandoned their use in this service. The maker of these ball bearings has made a request to be permitted to substitute roller bearings for his ball bearings.

As for the N. K. A. disk bearings, these have since been installed in additional express train equipment on the Swedish State Railways and are now being installed on "Stockholm, Wästeras, Bergslagens Järnvägar," Sweden, in express train service in France, and on the Danish State Railways. Disk bearings are also being applied in street car service in Copenhagen and Odense Sparvägar, Denmark, and are now in operation in Malmö, Sweden.

E. F. Maas.

(The statement regarding the service obtained from ball bearings was taken from a Consular report, which we had no method of verifying at the time. Apparently the report was misleading in this particular and we are glad of the opportunity to correct any erroneous impression that the article may have given rise to.) Editor.

NEW BOOKS

Developing Executive Ability. By Enoch Burton Gowin, 9 in. by 6 in., illustrated, bound in cloth. Published by The Ronald Press Company, 20 Vesey street, New York city.

While this book is designed primarily for the young executive, without particular reference to his attachment to railroad service, still there can be no question but that the subject is one which should be of keen interest to a very large number of railroad men. It is certainly the greatest personal and individual problem for every young man engaged in railroad service, as well as a problem of the greatest importance to many who have graduated into important executive officers with our railroads. Railroad officers are sometimes criticized on the ground that they do not handle their work with the same degree of precision and system practiced by executives in other business activities. The author, who is assistant professor of commerce, New York University School of Commerce, Accounts and Finance, has endeavored to show how the day's work may be so systematized that it can be cleared away with ease and precision, how the executive may utilize the time thus gained for constructive effort and for the development of mental vision, initiative and reasoning power, and show him how to develop and prepare himself for broader activities and greater responsibilities. The alert and ambitious railroad man, no matter what his relative position may be, will welcome any possible suggestions by means of which he can effect many economies of time, energy and money. The book is in no sense theoretical. It is simply a common sense analysis of those qualities which characterize executive ability and the means by which this ability may be obtained. It is more than interesting to note that in illustrating his point Professor Gowin has often referred to Harriman, Hill and Ripley, and it may be doubted whether the tremendous influence of the old school railroad executives on our modern business organization is even now fully appreciated. This is not only the kind of a book railroad men should read, but it is the kind of a book that they will want to read.

Powdered Coal as a Fuel. By C. F. Herington, 303 pages, 8 in. by 9 in., bound in cloth. Published by D. Van Nostrand Company, 8 Warren street, New York city.

This is the second edition of a book which made its appearance about two years ago, and represents both a revision and enlargement upon the original text, although at the time of its publication this book probably represented the best and most complete treatise upon this subject. Since that time it cannot be denied that powdered coal has assumed a wider field of usefulness and is now regarded as a most promising development. This applies particularly to industrial operation, as it has been demonstrated that the limitations imposed upon the locomotive in its present form make the successful application of this fuel to locomotive use decidedly problematical. However, it should be of particular interest to railroad engineers to know that one of the most successful installations of powdered coal under stationary boilers has been accomplished by the Missouri, Kansas & Texas Railroad at its Parsons, Kansas, shops. It should also be stated in this connection that the American Locomotive Company has met with considerable success in the use of powdered coal in its metallurgical furnaces at Schenectady. Both of these installations and other installations of similar character in industrial plants are described in detail. The author relies more upon descriptions of successful installations than upon theoretical analysis of the subject to demonstrate the possibilities of powdered coal. The book shows very completely just what is being done at the present time with powdered coal and may serve to convince many as to what can be accomplished with this fuel.

Mountain Type Features New Rock Island Power

Greater Steaming Capacity and Larger Driving Wheels Indicate Trend in Development of This Type

UPON return to private management, the Chicago, Rock Island & Pacific was one of the earliest to place large locomotive orders. These orders included 10 Mountain, 10 Mikado and 15 Santa Fe type locomotives all of which were purchased from the American Locomotive Company and constructed at their Dunkirk plant. None of these types is new to the Rock Island since this road has operated both Mikado and Santa Fe type locomotives of the same general design in freight service for several years and was one of the first railroads to adopt Mountain type locomotives for heavy passenger service.

The selection of these locomotives by a railroad that has had experience with each type is in itself significant and would indicate that the Mikado has made a place for itself which the advent of heavier power cannot usurp. It also serves to demonstrate that the Santa Fe type is here to stay and verifies the foresight of those who placed the Mountain type in passenger service on the Rock Island seven years ago.

When the first Mountain type locomotives were placed in service on the Chicago, Rock Island & Pacific, they enabled the consolidation of the St. Louis and the Chicago sections of the Colorado trains into one train west of Phillipsburg, Kansas, where maximum and ruling grades of 1.0 per cent are encountered. The trains hauled by these locomotives usually consisted of 10 or 11 all-steel cars weighing from 675 to 750 tons although as high as 1,175 tons in 19 cars have been handled successfully over a division of 140 miles.

Pioneer and New Mountain Types Compared

The policy of the Chicago, Rock Island & Pacific with respect to the design and equipment of new locomotives has been consistently directed toward obtaining maximum efficiency in operation and economy in maintenance. Therefore, a comparison between the pioneer and the new Mountain type locomotives affords an interesting commentary upon the development of this type practically since its initiation in passenger service.

It will be observed from the specifications which are submitted in connection with this article that the rated tractive effort of both locomotives is nearly identical, but that the weight of the new locomotives is considerably greater than that of the original Mountain type. The new locomotives weigh 29,000 lb. more on the drivers and are proportionately heavier throughout.

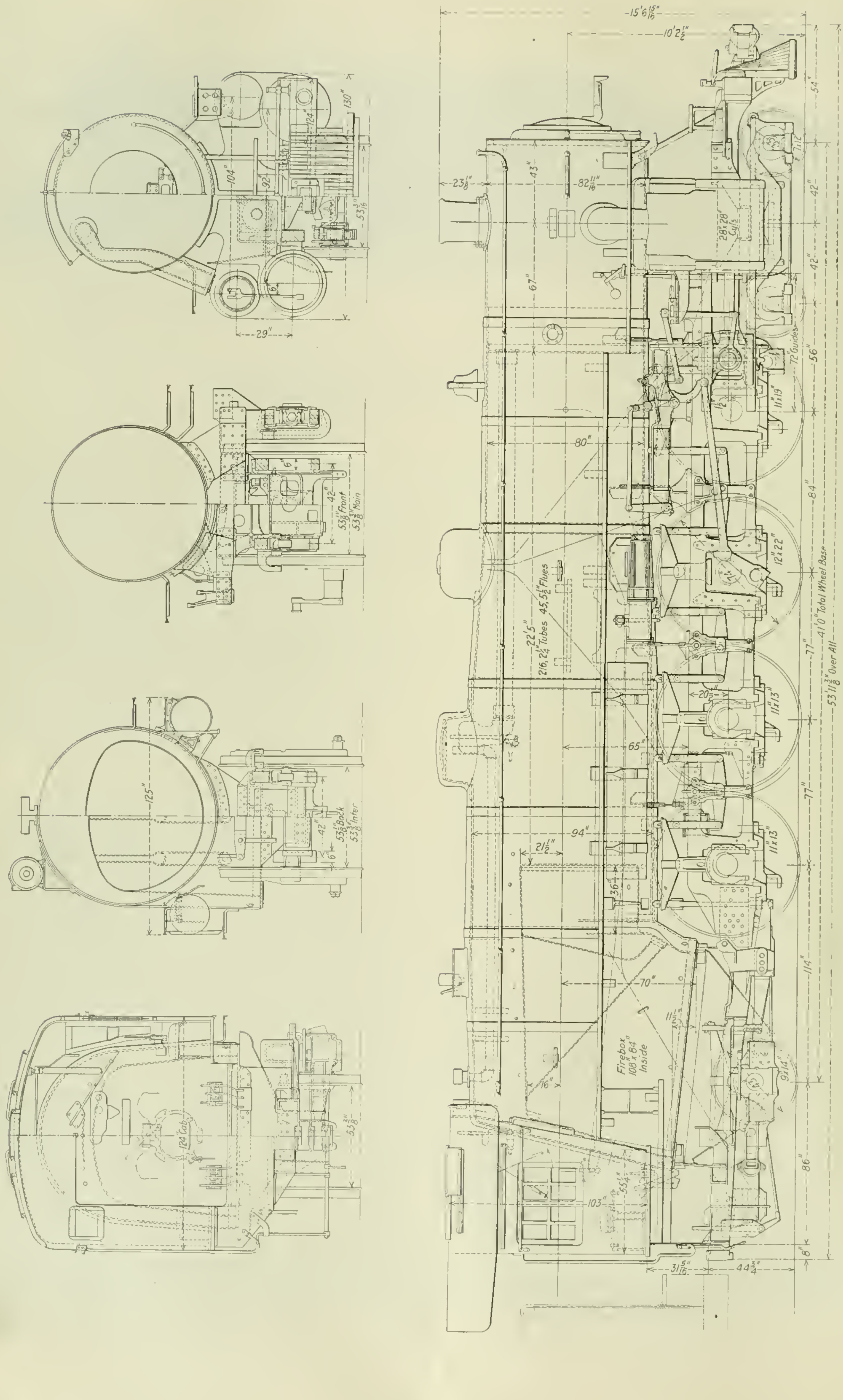
This increased weight is largely accounted for in the boiler dimensions as the total heating surface of the new locomotives, excluding the superheater, is nearly 600 sq. ft. greater. The greatest proportional increase occurs in the firebox heating surface of the new locomotives which is over 30 per cent greater than the firebox heating surface of the older locomotives. This increase is largely accounted for by the application of three thermic syphons to each locomotive as the other firebox dimensions, including the grate area, are practically the same.

The most striking difference in design, however, appears in the driving wheel dimensions, the new locomotives having 74 in. driving wheels as compared with the 69 in. wheels of the earlier locomotives. As the cylinder dimensions of the two locomotives are the same, it will be seen that the larger driving wheels tend to balance the larger boiler, which carries 200 lb. pressure as compared with 185 lb. on the original locomotives. These are the first Mountain type locomotives built with driving wheels as large as 74 in. and their ability to sustain high speeds with heavy trains will be watched with interest.

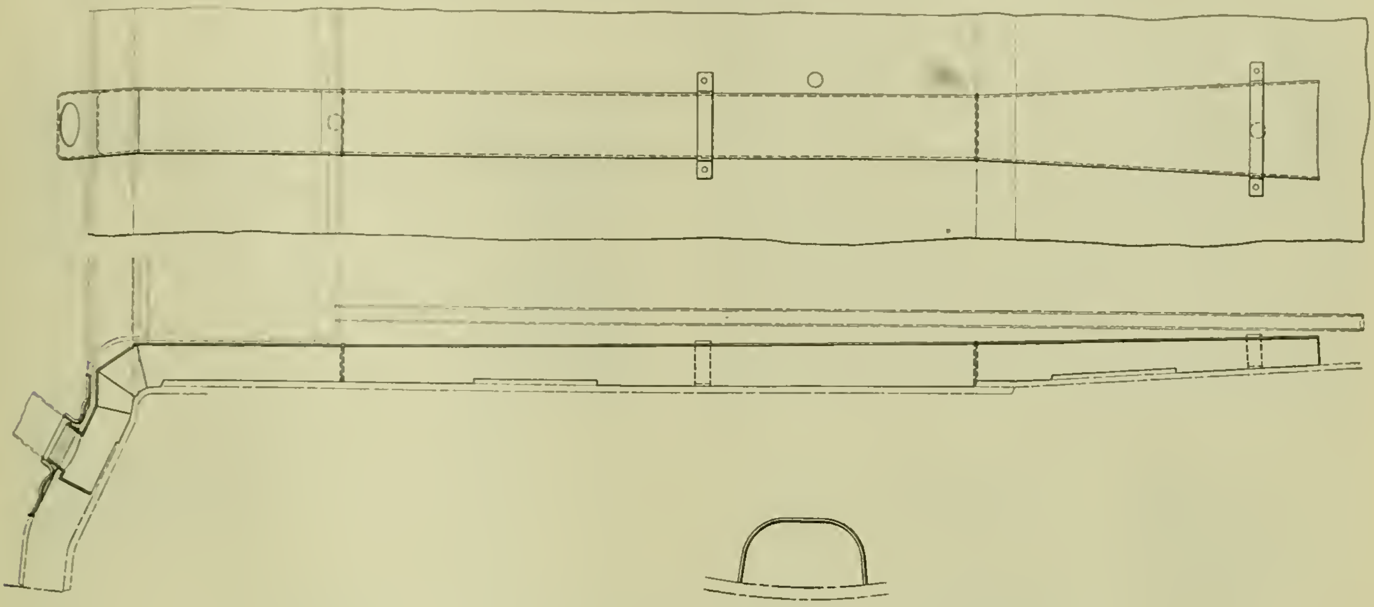
Special Features of the New Locomotives

Among the novel characteristics applying generally to all three classes of the new locomotives is the short slope of the cab front which permits all of the wrapper sheet staybolts to be outside of the cab so as to facilitate inspection and removal. All the piping is arranged so as to interfere as little as possible with inspection and minor repairs to staybolts. The location of cab appurtenances was given special attention in the design of these locomotives from the standpoint of both safety and accessibility. An outside steam turret is provided with extension handles to the valves so that all pipes having boiler pressure are located outside of the cab. The injectors also are located outside of the cab. The detached water column is specified in accordance with the recommendations of the mechanical standards committee of the Railroad Administration.

The tenders of these locomotives are of the Franklin type with unit draw-bar attachments and Commonwealth cast steel underframes. This is in distinction to the Vanderbilt type of tender which was constructed for the first Mountain type locomotives and has characterized the Rock Island locomotives for many years. It should be noted in this connection that the new tenders for the Mountain type locomotives have a water capacity of 10,000 gal. and carry 16 tons of coal in comparison to the tenders attached to the original Mountain type locomotives which had a maximum capacity of 8,500 gal. of water and 14 tons of coal. The locomotive tender has a low center of gravity with rounded bottom and corners

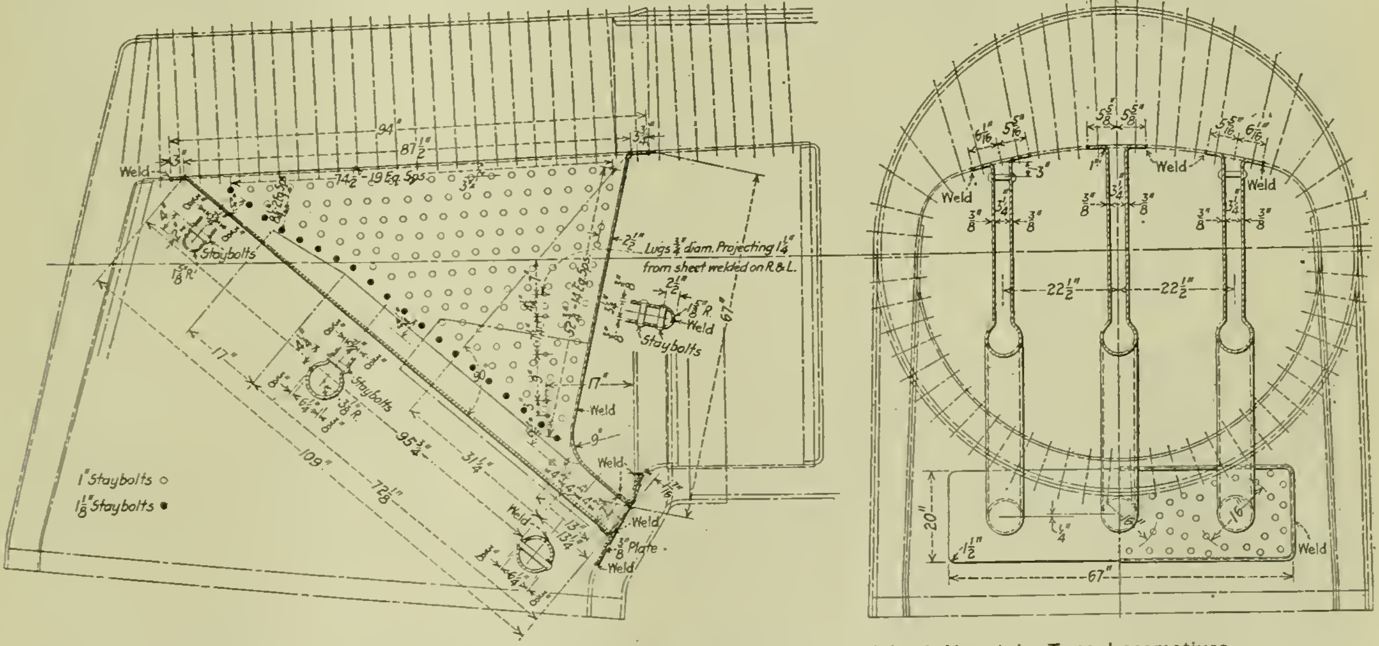


Elevation on Sectional Views of New Mountain Type Locomotives for Chicago, Rock Island and Pacific bringing the side and bottom sheet connection above the radius so as to eliminate the customary angle in the corners of the cistern to which the side and bottom sheet are attached and which usually give trouble on account of leakage.



Intake Channels for the Thermic Syphons Applied to New Rock Island Locomotives

We are indebted to W. J. Tollerton, general mechanical superintendent, for the following statement relating broadly to the principles governing the design of these locomotives:



Detailed View of the Nicholson Thermic Syphons as Applied to Rock Island Mountain Type Locomotives

"Many of the features on these locomotives were brought about by closely watching previous engines of similar design, and the idea has been to eliminate any weakness that may have developed; also the design is prepared with a view to the greatest possible reduction of possible future shop labor when the engine is overhauled, by easy accessibility of the different parts, and the idea of making each part, if possible, run from shopping to shopping without renewal. It must be appreciated now, more than ever, that anything that can possibly be done to increase mileage and get a quicker turn on the engine, both at the terminal and when passing through shop, should be anticipated at the time the design is made."

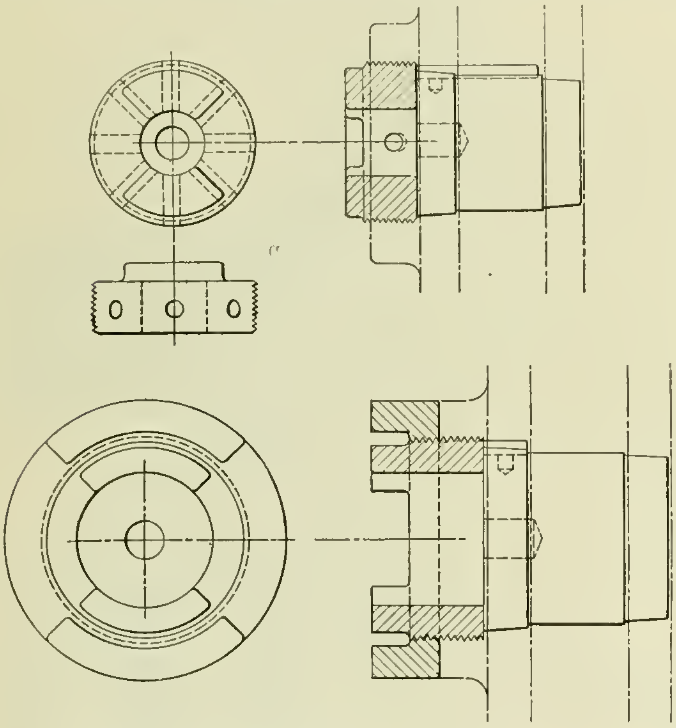
Special Equipment Applied to the New Locomotives

The most noteworthy addition to these new locomotives in the form of a specialty designed to increase economy and capacity is the Nicholson thermic syphon, the details of which are illustrated in connection with this article. While this device has been applied to locomotives on the Rock Island for over a year and is now giving satisfactory service on a number of other railroads, this is the first instance in which the syphons have been specified throughout on new orders of Mountain, Mikado and Santa Fe type locomotives. As will be observed from the specifications and drawings, the syphons add 141 sq. ft. of heating surface to the firebox and serve to support a brick arch in place of arch tubes. The purpose of the syphons is to increase the capacity of the locomotive by increasing the firebox heating surface as noted and to improve the circulation within the boiler resulting in a freer steaming and more economical locomotive.

Two other novel and interesting specialties applied to these locomotives are the wrist and knuckle pins, both of which are illustrated in detail. These designs are patented by the U. S. Metallic Packing Company and have the advantage of enabling the pins to be removed from the outside and the rods taken down irrespective of their position.

The new locomotives are all equipped with force feed lubricators, Barco flexible steam heat and air brake connections, Alco power reverse gears, Baker valve gear, the Woodward engine truck, oscillating front driving box, Franklin adjustable driving box shoes and wedges, hollow main crank pins with internal grease lubrication and adjustable hub plates by means of which the lateral can be taken up without dropping the wheels.

The locomotive smoke-box is equipped with the Unit spark arrester which is cylindrical in form and can be readily removed through the front door. Franklin grate shakers are applied to all of the locomotives but stokers of the Duplex type are applied only to the Santa Fe type locomotives as it has been found entirely practical to meet the maximum service requirements on Mountain and Mikado type locomotives by means of hand firing and it was thought that the application of syphons would further improve the free steaming qualities of these locomotives. However, the Mountain type locomotives are designed so that stokers may subsequently be applied if found necessary.



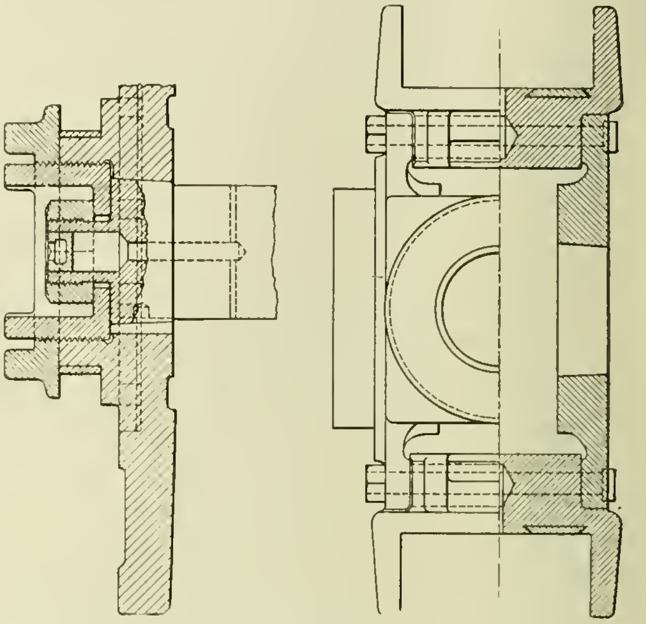
Removable Knuckle Pins Applied to New Rock Island Locomotives

In addition to the Alco standard drifting valve these locomotives are equipped with an auxiliary saturated steam line to the cylinder. A manually operated quick opening 1¼ in. starting valve is connected to a 1¼ in. pipe extending from the turret to the front end of the boiler. From this point, 1 in. branch pipes lead into each steam pipe. A copper pipe, having its own connection from the hydrostatic lubricator in the cab, is led to this steam line. A 1¼ in. tee is also inserted near the cab for emergency oiling of the piston valves by the engineman in case the force feed oil pump fails en route.

Mountain Type Locomotive Dimensions

The Mikado locomotives purchased by the Rock Island last year do not differ materially in design from locomotives of the same type which have been in service on the railroad for some years and the new Santa Fe type locomotives are substantially the same in design as the locomotives of this type built for this railroad in 1918 and described in the January, 1919, issue of the *Railway Mechanical Engineer*, page 41.

For convenience the principal dimensions of the Mountain type locomotives which were constructed for the Rock Island in 1913 and referred to in the foregoing are tabulated together with the dimensions of the new locomotives as follows:



Sectional Views of Crosshead, Showing Novel Wrist Pin Design

	Chicago, Rock Island and Pacific Mountain Type Locomotives	
General Data:	Built in 1913	Built in 1920
Tractive effort	50,000 lb.	50,400 lb.
Cylinders, diameter and stroke	28 in. by 28 in.	28 in. by 28 in.
Weight in working order	333,100 lb.	369,000 lb.
Weight on drivers	224.100 lb.	253,000 lb.
Weight on leading truck	57.500 lb.	57,000 lb.
Weight on trailing truck	51.500 lb.	59,000 lb.
Weight of engine and tender in working order	490,500 lb.	559,000 lb.
Wheel base, driving	18 ft. 0 in.	19 ft. 10 in.
Wheel base, total	38 ft. 11 in.	41 ft. 0 in.
Wheel base, engine and tender	70 ft. 2¼ in.	79 ft., ¾ in.
Ratios:		
Weight on drivers ÷ tractive effort	4.48	5.02
Total heating surface ÷ grate area	6.66	7.32
Total heating surface ÷ grate area	65.4	74.4
Per cent firebox heating surface to evaporative surface	7.50	8.66
Per cent superheating surface to evaporative surface	22.9	26.6
Total evaporative surface ÷ volume of cylinders	206	234
Grate area ÷ volume of cylinders	3.14	3.15
Wheels:		
Driving, diameter over tires	69 in.	74 in.
Driving thickness of tires	3½ in.	4 in.
Driving journals, main, diameter and length	11 in. by 22 in.	12 in. by 22 in.
Driving journals, others, diameter and length	11 in. by 13 in.	11 in. by 13 in.
Engine truck wheels, diameter	34 in.	33 in.
Engine truck journals, diameter and length	7 in. by 12 in.	7 in. by 12 in.
Trailing truck wheels, diameter	42 in.	43 in
Trailing truck journals, diameter and length	9 in. by 14 in.	9 in. by 14 in.
Boiler:		
Style.	Conical	Conical
Working pressure, pounds per sq. in	185 lb.	200 lb.
Outside diameter, first ring	78 in.	80 in.
Firebox, length and width	107½ in. by 84 in.	108 in. by 84 in.
Tubes, number and outside diameter	207—2¼ in.	216—2½ in.
Flues, number and outside diameter	36—5½ in.	45—5¼ in.
Tubes and flues, length	22 ft.	22 ft. 5 in.
Heating surface, tubes and flues	3,805 sq. ft.	4,283 sq. ft.
Heating surface, firebox	312 sq. ft.	406 sq. ft.
Heating surface, total	4,117 sq. ft.	4,689 sq. ft.
Superheating surface	944 sq. ft.	1,247 sq. ft
Grate area	62.7 sq. ft.	63 sq. ft.
Tender:		
Tank.	Cylindrical	Rectangular
Water capacity	8,500 gal.	10,000 gal.
Coal capacity	14 tons	16 tons

Getting Better Results From Railroad Organizations*

The Subordinate Officer Occupies a Strategic Position, but Is Not Properly Trained to Fill It

BY GEORGE M. BASFORD

DISCUSSIONS on reducing cost of transportation do not really begin before someone mentions the real key to the situation, which is effort of the individual all along the line to improve his production, to save. The next thing mentioned is the foreman and supervision. The foreman today is the most vital influence on the road.

Giving my conclusion first I am going to suggest what seems to me to be an absolutely unquestionable necessity on railroads today. I am going to suggest a foreman for a new job. The job is to take charge of the whole railroad organization as an organization, as a general foreman of personnel, but the man would have a title and standing that places him next to the chief executive of the road. This officer would supply a missing link in our troubled days. The chief executive was formerly so close to the small organization that he could know every man. Not only did he know every man, but he handed to them, by contact, his ideals, his desires and his inspiration. As organizations grew this link was lost. It must be found again. At this precise point in the development of railroads, and in the present complication of their problems there is nothing to be done that will net as much as securing the co-operation of the rank and file for increased production and the reduction of cost of transportation. The minute the men in the ranks, on the track, in the shops, yards, terminals, trains and engines center their minds to the fact that the best thing they can do for themselves, for the railroads, and for the public, is to get busy to save dollars, the railroads will be saved.

It is not enough that some should be striving or that some departments should be organized for effective effort of the individual. It is necessary that the effort should be general, bringing departments into combined efforts. Now we hear men say, "I should worry, the coal is not charged to my department." To answer this there must be some way for these men to learn the policy of the road with respect to coal, and the policy with respect to everything they use.

It Takes a Shock to Wake Us Up!

Is it radical, is it revolutionary to suggest a high officer for the exclusive administration of the organization as an organization, who will himself be a part of the policy of the company and whose duties are to see that everybody from himself down to unskilled labor understands that policy? Sometimes it takes a shock to wake us up. Right now we are having one. Until organization questions receive some sort of consistent attention we shall continue in trouble and in trouble that has a remedy.

How can anyone defend such a thing as this? An important department of one of our fine big railroads has not once in 30 years been presided over by an officer who grew up on that road and in that department, but in this time many importations have been made. All have been able officers but they came from "outside." Think this over!

Another big road recently had a narrow escape. A vacancy in a high position was about to be filled by an outsider when the president's attention was called to a man already in the service, who for years had been preparing for exactly that position. He was promoted. He has made good. Some say, "We need new blood." The answer is you already have it. Circulate it. Every time a stranger is imported to a high position notice is served on the entire organization that it is useless for the individual to exert himself. This is just what has happened on many of our railroads. When foremen and men see this why should the men desire to be foremen and why should foremen wish to go higher?

"Give me a bunch of good foremen and the yard will run itself," says the ship builder.

A Picture

Two years ago a large industrial organization started such a plan. It involves 15,000 men in a number of plants and includes a very large office and sales force in this country and abroad. A remarkable man was selected to manage personnel, training and promotion. He reports to the board of directors and works with the executive assistant to the president. Policies are established by conferences in which the personnel officer has a part. He carries these policies out through and with the organization, everybody knowing that he represents the highest authority. He has begun with recruiting, training and promotion questions, is developing co-operation such as is seldom seen and has made remarkable headway in better understanding among not only the different plants of the company but among the officers and men of individual plants.

To succeed the policies must be definite and the objects of the organization must be known. This officer is supplying through the organization itself that which was lost when great growth came. He is bridging the distance that was rapidly increasing between the executives and the men. He has established apprentice schools, workmen's schools and foremen's schools, which means that the foremen are studying men and methods of dealing with them and are becoming managers of men. The work he is doing is entirely applicable to the railroad, the small road as well as the large one. The railroad needs the facts he is collecting. Who have we got in our employ? What is he doing? What is he capable of doing when trained to do it? The roads need the job analysis he is making for his company and the system he is working out to find and fit men to the jobs.

Chief Clerk

Let us think a moment how chief clerks are selected. It is a personal matter with the officer. Chief clerks sign the officer's name, take action for him in his absence. I have seen over one hundred officers of a certain road in conference for several days at headquarters here in Chicago—while the chief clerks ran the road. Because this is personal service these men are selected with personal care and from men who have been through long periods of training. Naturally they make good. We should therefore think of two things in this case.

First, these men are often good material for promotion. Think of this—the chief clerk is close to his superior. He absorbs from his superior the things that made that superior successful. He grows by his contact with a bigger man. This is training, of the sort that we are talking about. Moreover, the chief clerk is in an exposed position where good work shows up quickly and clearly. Let us get the obscure men up into a brighter light and see what happens.

Second, every man on the road must and does act for the

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*From an address before the February meeting of the Western Railway Club.

boss in his absence and should be selected with equal care and should be trained as well. Every man signs the name of the boss on every job he does and the railroad is about 150 ft. to 200 ft. wide and perhaps 2,000 miles long. The boss is necessarily away most of the time from most of his subordinates.

Biggest Job on the Road

Someone has said that "the foreman is the top sergeant of industry." Nothing is more true or more important in any industry than this. The character of an organization is up to the character, ability and progressiveness of the foreman. No matter who or what the captain is, the company is practically useless unless the top sergeant is right. If the foreman is a timeserver, as sometimes he has been taught to be, the men will be timeservers also and the result is well known. Who on a railroad ever gets shop foremen or yard foremen together to tell them how important their jobs are and to show them that to their men they represent the railroad? Are they encouraged to know the manhood, ability and possibilities of their men? Does the foreman look with his own eyes alone or does he look with the eyes of the management? Does he know his men when off the job? Is he their friend and advisor?

How is a new foreman selected when a foreman leaves? He may be most skilled with his hands and may be most proficient with his own work, but he must know how to manage and operate the most complicated, most delicate machine in the world—a human organization with intricate problems always present. Is he usually told about the management of men and is he helped and supported as he should be in that management?

Some big successful industries are getting to a point of appreciating what foremen can do and are already holding foremen's schools and foremen's meetings to bring these important men to see their own possibilities. Remarkable results are being obtained by leading the foremen to realize that they are really administrators of human affairs, that they require wisdom as well as ability, that an army is what its commander makes it, that the gang reflects the leader and that the leader must know and have the confidence of the men he leads.

In the question of shop foremen a new situation developed instantly when piecework was abolished. Is it not true that piecework furnished the incentive to the individual worker, whereas incentive in earlier days had been supplied by the foremen? Under piecework the foremen deteriorated, in some cases to the mere checking of work. Foremanship received a knockout when, by piecework, men received more than the foremen did. When piecework disappeared this left many roads with foremen who were not trained at all and did not know how to furnish the incentive to the men. This is not the fault of the foremen, but of the system of things which changed. It confirms the opinion that the loss of inspirational contact has been serious.

The Traveling Engineer

Is it possible that these vitally important men can get closer to the men on the engines and represent to them the ideals and the humanity of the wonderful organization of a railroad? There is no finer body of men than those who run our engines, but as a body what do they know, what do they see of the management? It is represented to them by rules, the breaking of which means trouble. These men can affect the treasurer's figures more than any other class of men on the road. For instance, they can improve ton-mile figures more than anyone else can. I believe that a 10 per cent saving in fuel lies in the hands of these men whenever the desire to save it is made an ideal with them and when the idea of saving is "sold" to them.

Roundhouse Foreman

Here is the man who must be the manager of his men. He is often isolated and must rely on himself and frequently faces great difficulties of weather, lack of facilities, even of conveniences, and without sufficient subordinate supervision in his work. His work is a continuous emergency. A big roundhouse job is as big as the head of the department had a generation ago.

The new officer we are talking about would give the roundhouse foreman great encouragement, would help him get the facilities he needs inside and outside of the roundhouse. This officer would be able in a short time to provide him with trained men. Here is a good place for a start to be made in reducing idle time of engines. Here is where industrial intelligence counts heavily. Co-operation counts most of all. Despatchers should understand the roundhouse. Traveling engineers should spend enough time there to understand how engines come in off the road.

Recruiting Officers

Without a systematic method for taking recruits into employment, without insisting that employing officers should work to a certain plan or system the character of recruiting will depend largely upon and will be limited by the ability, the personality and methods of those who do the hiring. Various manufacturing plants employ highly trained recruiting officers in employment offices. Some concerns go so far as to employ psychological tests, others use intelligence tests, means for selecting recruits having become a science. We may hold different opinions as to the tests suggested and used, but it seems decidedly necessary that greater care in some form should be exercised, especially in recruiting for permanence. Those who have made exhaustive study of employment officers and recruiting officers in industries say that there is no case on record of this work having been abandoned when once started.

Employment management in industry has become a profession, devoting itself to getting and keeping men through uniform, consistent policies.

Recruiting Along the Road

Let us select for various jobs young men and boys who are recommended because of character, physical ability and the necessary intellect. One way to select them is to enlist the aid of local officials along the line of road. Station and local officials of all departments may be asked to recommend those they know about or whose parents they know. The headmaster of the grade school or the principal of the high school, the clergy, and even the local judge may and will recommend the best material when they are interested to do so. Having in mind office boys, apprentices and young men it stands to reason that living along the line of the road they will already have an interest and an embryo undeveloped loyalty to the property from which the loyalty so greatly needed under present conditions may have promise of development. Wherever this is done the results have justified the plan and it seems worthy of consideration.

Labor Turnover

To engage new men, teach them their duties and launch them into service costs a lot of money. To engage, train and then lose them in large numbers is a very serious loss. It is one of the biggest leaks in industry. To hire and lose a skilled man costs from $250 to $300 in one industry which has been studied. It must cost railroads more than that because in many cases great damage is done by such men. I know of one large railroad shop which for three years in fairly busy times had not found it necessary to go beyond its own apprentice graduates to supply all the skilled talent needed and in that period no skilled workman was hired from outside.

Inspiration

A large majority of men take pleasure in accomplishment of a good piece of work. Making something, repairing something or making a good run over the road brings satisfaction and is in itself an inspiration. Praise is often in order but must be used with discretion, so also censure. Notice taken in either case indicates that the company cares whether work is done well or not and most men will respond.

A road had three shops far apart and a flue job at each. One of the flue gangs had made a record. The leaders of the gangs at the other shops were sent to investigate. They went back and beat the record. This was not all. All three flue jobs were overhauled, new machinery installed and a lot of money saved. Mere expression of interest inspired these men to do good work and they were happier for doing it. It is a part of training of men to show them that the job they are doing is of great importance to the road.

Friends

Everybody needs a friend. Every young man finds a turning point in his career, a point in his life when he wakes up to a realization of his responsibility and his opportunity. It may be that a word of advice, of caution, of recommendation given at the right time will make, and the absence of it will break a career. It is most fortunate if this friend is his employer or the representative of his employer, the foreman, the general foreman, the master mechanic, the train master, the chief despatcher. In older days when organizations were small it was the boss himself. In these days of big things it is the representative of the boss. The most important thing a big organization can do is to provide the thing that bigness has outgrown—personal contact with big unselfish minds, minds big enough to give a point of view to an individual. The employer is really the best friend of the employee. If this is not true in any case it must be made true. Then it must be understood by every officer and every workman. How shall this be done? It must be somebody's business to get it done.

Good Soldiers

Nobody ever wanted "good soldiers" as railroads want them now. Railroad men are good soldiers, but who are their leaders and why? Most men are followers, in fact everyone is a follower of some sort. We worship heroes and ideals. We follow leaders more able, capable or perhaps more dominant than ourselves. Shall we follow our superior? That depends upon their leadership and we are "company men" or "organization men" depending on the influences and their strength.

What is to be done about it when others lead our people away? Is there nothing we can do? Let us remember that the "old man" used to be the leader, and let us consider the possibility of regaining some of his leadership in the days that are to come. It will be needed. Men always have followed and always will follow those whom they think "get" them most. It is important to find a way to discover, recognize and reward individual ability.

Discussion

Talking things over brings co-operation. When people get together for discussion responsibility is necessarily forced upon those present and the natural tendency is to look at the question from the other man's point of view. This is the value of meetings, especially when the object is to reveal and develop the importance of the person who has a tendency to consider himself obscure and overlooked. Nothing in any organization helps so much as for this man and that man to stand up and tell in his own way what or who is holding him back. When the accused must answer the chances are that more complete understanding will be reached. The chief who is present is not the only one who will begin a liberal education from discussions with his foremen or his men.

Apprenticeship

I use the word apprenticeship with hesitation simply because to most people it suggests merely "trades." It really represents training, thorough training of the hands, of the mind and of the morals of the lad. What we need today is a modern up-to-date substitute which will fit the times and the change from an employer with one employee to the multiple employer with thousands of employees. The principles involved remain the same. Let me quote from a report of a Massachusetts Commission on industrial training:

"In many industries the processes of manufacture and construction are made more difficult and more expensive by a lack of skilled workmen. This lack is not chiefly a want of manual dexterity, though such a want is common, but a want of what may be called industrial intelligence. By that is meant mental power to see beyond the tasks which occupy the bench for the moment, to the operations which have preceded and to those which follow it—power to take in the whole process, knowledge of materials, ideas of cost, ideas of organization, business sense and a conscience which recognizes obligation."

Consider what the sort of training this suggests would mean in saving money for the railroads, applicable as it is to every department, every office, the track, the yard, the terminal, the roundhouse and of course the shop. Apprenticeship of this kind should not, by any means, be limited to the shops. Some roads, notably the Santa Fe, have faithfully developed apprenticeship and have enjoyed wonderful results. This road should be proud of the 1,506 graduates of its apprenticeship courses. What has been done with shop trades should now be extended to every department, every office and every job.

Selling an Idea

Experience in selling something to people who think they do not want it would help the leaders of big organizations more than they know. An organization must have ideals. To succeed these must be sold to those who are to carry out the principles—to the official staff and by them they must be sold to the rank and file. Is the ideal of reduced cost of transportation sold to the men in the ranks? Do many of the men say, "What do I care? There is more coal, more material, and more time where this came from." When the ideal that the roads are working for is sold to the men the present labor problem will be simplified. Foremen and subordinate officials can and I believe will accomplish this in the future, but selling necessarily involves something to sell—which in this case is not lacking—and ability to bring the purchaser's mind to the need to buy.

Looking Ahead

How are we to look ahead when we have so many troubles in hand? Troubles we shall always have and if years ago we had looked into the future on the personnel question our difficulties today would be less. If we do so now they will be less ten years from now.

In the development of railroads a lot has happened since the day when a road was so small that the superintendent was the only operating officer—when the master mechanic and everybody else, having to do with operation, reported to the superintendent. The old "Czar" system has gone. In that system the "Old Man" held everyone's job in the palm of his hand, hired and fired as he liked, rewarded and punished as the old-time head of the family rewarded and punished his children and there was no one to question him. In those days the captain of a ship held little more power than the railroad official.

There was something fine about the old method when the highest operating officer knew everybody. In spite of the faults of the system, which really was the best system for the time, it has left us some of the best traditions and has given transportation service some of the best of men. It gave co-operation. Co-operation had to be because there was someone on hand to enforce it. This effect of co-operation has probably done more than any other one thing to tie railroad men together and make so many of the old-time railroaders feel that any man in railroad service was, in a large sense, a member of his own family. This feeling is not as strong today, co-operation is not as common, but it is, and will remain, a factor that we cannot do without. It must be provided.

Another feature of old-time railroading was the training of men. I refer not only to apprenticeship, but to the careful training of every new man for his job. As a matter of course boys entering the shops were apprentices, so also were firemen, brakemen and switchmen and all the rest. In those days somebody had time to instruct new men. Whatever else we say of those days, certain features of the times indicate a thoroughness which we do not get today. In days of old, promotion was controlled by prejudice, by favoritism, sometimes by family ties, but with all the faults of the early days, men were seldom imported from other roads.

No one wants the old days back, but it is fitting to consider features of the old which should be provided with the new. Some of these are the careful selection and training of new recruits, the spirit of the railroad men of older days, co-operation and the intimate knowledge of the men in the ranks on the part of someone in authority. Of all the things we need to take out of the past and apply to the future, the things we need the most are the selection, the training and the knowledge of men. Railroads are too big, even departments are too big to permit the operating officers to know who are working for them, but some substitute for these features of old times must be found. A way must be found for foremen at least, or sub-foremen, thoroughly to know the men working for them, their personalities, their capacities, their abilities and their qualifications for promotion. This and the selection and training of men may be supplied under present conditions and may yet make railroad service as happy as it ever was, but to accomplish this requires a lot of thought, a lot of time and a definite plan which will enlist the co-operation of the men. It calls for a high officer whose job it is to see it done.

When specially trained men were wanted in 1918, C. R. Dooley and staff delivered 100,000 trained men to the army in six months and had 40,000 more nearly ready when the armistice was signed. About 70,000 of them went across, men trained in 67 different trades. These men were selected as well as trained. Nothing that lies before the railroads is as difficult as that. The report which outlines the problem, the plan, the organization and the execution will open the eyes of any man who does not know about modern training methods.

When railroads start in to tackle their production problem in as thorough a fashion and with as complete a plan, cost of transportation will come down. Nothing will influence the workers as a real plan will do it. When they understand the plan, its objects and the country's need of it the workers will want to do their part and without their earnest efforts in co-operation success is out of the question.

There is no other way. An enlightened mind is the greatest asset on earth.

Our high official in charge of personnel cannot be expected to change the atmosphere of the organization quickly. He will not himself attempt to make the change. He will not himself attempt personally to train everybody. He will see that everybody on the road is trained, that every officer trains his own successor. He will see to it that men are specified and treated as carefully as steel and iron are. He will use the entire organization and will inspire everyone in it by concentrated effort to bring out the best in every individual in the direction of enlightened team work.

Reducing the Fuel Consumption of Power Plants

BY WILLIAM N. ALLMAN

(Continued from the February Issue)

When it is considered that only about 57 per cent to 67 per cent of the coal that is consumed in the average plant is utilized for producing steam, it becomes clear that it is also quite an important matter to retain the heat in the steam and not allow it to escape through lack of proper insulation.

Heat is much more evasive than gas, it escapes through a boiler plate or pipe about like water through a sieve. When it is considered that steam carrying a pressure of only 100 lb. per sq. in. has a temperature of about 338 deg. F. and that on the hottest summer day 90 deg. to 100 deg. F. would be extremely hot, it will be readily observed that there is a tremendous waste due to leakage if proper insulation is not provided for.

The real object of insulation is to prevent the flow of heat from the container to the outside atmosphere. It has often been noted that great care is exercised in guarding against losses in electrical distribution and water leakage and also against undue loss in steam pressure between the source of power and the prime movers, and not until quite recently has there been the great care given to insulation that now manifests itself. The losses in heat units through poor insulation have now become a vital factor in power plant operation, and power plant engineers and managers are very busily engaged in determining where the losses may be reduced by insulation.

TABLE 1—TOTAL HEAT LOSS IN B. T. U.'S PER HOUR PER LINEAL FOOT OF BARE PIPE OF DIFFERENT SIZES AND AT VARIOUS TEMPERATURE DIFFERENCES AS GIVEN BELOW

HEAT LOSS IN B. T. U. PER LINEAL FT. PER HOUR

(For finding losses at temperatures between those shown, the B. T. U. Differences per Degree are given in Column between the Main Columns or Degree Columns)

Pipe size, in.	Area of pipe surface per lin. ft.	Temperature differences																		
		50°		100°		150°		200°		250°		300°		350°		400°		450°		500°
½	.220	21.5	.52	47.3	.64	79.2	.76	117.3	.90	162.3	1.06	215.2	1.28	279.1	1.52	355.1	1.93	451.4	2.37	569.8
¾	.274	26.8	.64	59.0	.79	98.6	.96	146.8	1.11	202.1	1.33	268.5	1.58	347.6	1.89	442.2	2.40	562.2	2.95	709.7
1	344	33.6	.81	74.0	1.00	123.8	1.19	183.4	1.41	253.7	1.67	337.4	1.98	436.5	2.37	555.2	3.03	705.4	3.69	891.
1¼	.435	42.5	1.01	93.6	1.26	156.6	1.51	231.9	1.78	320.8	2.09	425.4	2.53	551.9	3.00	702.1	3.80	892.6	4.68	1126.7
1½	.498	48.7	1.17	107.2	1.44	179.3	1.72	265.4	2.04	367.3	2.39	487.	2.90	631.8	3.44	803.8	4.36	1021.9	5.36	1289.8
2	.622	60.9	1.46	133.9	1.80	223.9	2.15	331.5	2.54	458 7	2.99	608.3	3.62	789.2	4.29	1003.9	5.45	1276.3	6.69	1611.
2½	.751	73.4	1.76	161.6	2.18	270.4	2.60	400.3	3.07	553.9	3.61	734.5	4.37	952.8	5.19	1212.1	6.58	1541.1	8.08	1945.1
3	.917	89.6	2.15	197.3	2.66	330.1	3.17	488.8	3.75	676.3	4.41	896 8	5.33	1163.4	6.33	1480.	8.03	1881.7	9.87	2375.
3½	1.047	102.3	2.46	225.3	3.03	376.9	3.62	558.1	4.28	772.2	5.04	1024.	6.09	1328.4	7.23	1689.9	9.17	2148.4	11.3	2711.7
4	1.178	115.1	2.77	253.5	3.41	424.2	4.07	627.9	4.82	868.8	5.67	1152.1	6.85	1494.6	8.13	1901.3	10.3	2417.3	12.7	3051.
4½	1.308	127.9	3.07	281.5	3.79	470.9	4.53	697.2	5.35	964.7	6.29	1279.2	7.61	1659.5	9.03	2111.1	11.5	2684.	14.1	3387.7
5	1.455	142.2	3.42	313.1	4.21	523.8	5.03	775.5	5.95	1073.	7.00	1423.	8.46	1846.	10.0	2348.4	12.7	2985.7	15.7	3768.5
6	1.733	169.4	4.05	371.9	5.04	623.9	6.00	923.7	7.09	1278 1	8.34	1694.9	10.1	2198.7	12.0	2797.1	15.2	3556.2	18.6	4488.5
8	2.257	220.6	5.30	485.7	6.54	812.5	7.81	1203.	9.23	1664.5	10.8	2207.3	13.1	2863.6	15.6	3642.8	19.8	4631.4	24.3	5845.6
10	2.817	275.4	6.62	606.2	8.16	1014.1	9.75	1501.5	11.5	2077.5	13.6	2755.	16.4	3574.1	19.5	4546.6	24.7	5780.5	30.3	7296.
The following losses apply to flat as well as curved or cylindrical surfaces:																				
B. t. u. Lost per sq. ft. per hour.....		97.5	2.35	215.2	2.90	360.0	3.46	533.0	4.10	737.8	4.80	978.0	5.83	1269.4	6.89	1614.0	8.73	2050.6	10.8	2590.0

Inspection of Table No. 1 will readily convey the enormous loss in B. t. u.s from uninsulated or bare surfaces and it is a surprising fact that this condition has been allowed to exist so generally. It has been estimated that the loss of heat from a bare or poorly insulated surface represents a loss in fuel ranging from 25 per cent to 65 per cent and principally for the reason that the escaping heat is not visible this can hardly be realized. If on the other hand it were visible, it would be so perceptible that steps would very quickly be taken to correct this evil and prevent the loss.

The efficiency of an insulating material is expressed by the percentage of heat saved by using the insulation as compared to what would be lost if no insulation were used and the surface left bare or uninsulated.

The efficiency of all insulation varies according to the size of pipe to which it is applied and according to the difference in temperature between the steam in the pipe and the air surrounding the pipe, as well as according to the thickness of insulation. Therefore the rate of flow of heat through a certain thickness of material and at a certain difference in temperature, determines the conductivity of the material. The relative efficiencies of insulating materials are obtained by comparing their conductivities under similar conditions. Heat is also frequently wasted where sections of insulation are not properly joined or where fittings are exposed.

Table No. 2 shows what losses may be expected from uninsulated surface. The figures are conservative, as both the boiler efficiency and the heat value of the coal are high and a lesser boiler efficiency or inferior grade of coal would cause even a greater waste in pounds of coal.

Table 2—Heat Losses from Uninsulated Hot Surfaces
ordinary steam temperatures

Temperature of Surrounding Air 70 Deg. F.

Steam pressure (gage)	Steam temperature (deg. F.)	Difference between temperature of steam and surrounding air (deg. F.)	Loss per sq. ft. per hour (B. t. u.)	Waste of coal in lb. per sq ft. per year	Number of sq. ft. of surface that wastes a ton of coal in 1 year
0	212	142	334	293	6.82
10	240	170	425	372	5.38
25	267	197	522.5	458	4.37
50	298	228	644	564	3.55
75	320	250	737.5	646	3.10
100	338	268	820	718	2.79
150	366	296	960	840	2.38
200	388	318	1,079	945	2.12
250	406	336	1,184	1,036	1.93

Temperatures Lower Than 212 Deg. F.

Surface temperature (deg. F.)	Difference between surface temperature and surrounding air (deg. F.)	Heat loss per sq. ft. per hour (B.t.u.)	Waste of coal in lb. per sq. ft. per year	Number of sq. ft. of surface that wastes a ton of coal in 1 year
100	30	56.6	49.6	40.3
120	50	97.5	85.4	23.4
140	70	142	124.3	16.1
160	90	190	166.3	12.03
180	110	242	212	9.44
200	130	298.5	261.5	7.65

Table 3—Minimum Thicknesses of Steam Pipe Insulation That Should Be Used for Given Character of Service

Steam pressures	Steam temperatures	Thickness of insulation for pipes larger than 4" in size	Thickness of insulation for pipes 2" to 4" in size	Thickness of insulation for pipes ½" to 1½"
0 to 25 lb.	212° to 267° F.	1" or standard*	1" or standard*	1" or standard*
24 to 100 lb.	267° to 338° F.	1½"	1½"	1" or standard*
100 to 200 lb.	338° to 388° F.	2" or double standard	1½"	1½"
Higher pressures	388° to 500° F.	2½"	2" or double standard	1½"
or superheat	500° to 600° F.	3"	2½"	2" or double standard*

For higher temperatures obtain special recommendations.
*Standard and double standard thickness apply to 85% magnesia insulation only—other thicknesses apply to all types of insulation.
It is always preferable to apply insulation greater than 1½-inch thickness in two or more layers with all joints broken or staggered.

The selection of the proper insulating material with due reference to its insulating efficiency and durability should follow a careful analysis of the conditions and requirements of the case under consideration. The greatest savings, of course, are to be effected by the proper insulation of the high pressure and high temperature steam lines.

Not every pipe covering is a good insulator, under all conditions; some may be effective at low temperatures and comparatively worthless at high temperatures. Again some insulators are fairly good on the initial application but soon deteriorate with age and the subjection to constant heat.

In the selection of an efficient covering it is highly important to consider its heat resisting qualities, mechanical ability to withstand ordinary wear and tear, and the effect of expansion and contraction of the pipes. To obtain more horsepower from the coal pile is the chief aim of all power plant managers and engineers and certainly after all that has been said and written on this most important subject of fuel conservation, those places in the power plant that spell "loss" will not be passed up and remain unnoticed.

Another appliance, which no doubt is overlooked and perhaps not considered as a losing factor is the steam trap. The loss of steam through open pet cocks or through leaky traps is quite large. This loss may be attributed to certain defects in the device and it is therefore highly important that they receive frequent inspection. .

General Suggestions

The United States Fuel Administration made every effort to bring home to fuel users the gravity of the situation and the importance of coal and power economy, and only by the whole-hearted co-operation of all concerned in the operation of the plant can the desired savings be effected.

The call for men trained in combustion efficiency is now more insistent than ever before. Everywhere the cry is for greater fuel conservation, more efficient methods of firing and the elimination of waste. Therefore, the man whose training enables him to solve these problems scientifically is offered unlimited opportunities as well as setting a standard for his subordinate. The Fuel Administration during the war advocated keeping a record of the temperatures of the flue gases as they leave the boilers. It was stated that with this knowledge the engineer could find the highest working efficiency and immediately discover sources of waste, while without this knowledge operation is mere guesswork.

All chief engineers, operating engineers, and firemen know, or at least should know, that decreasing the temperature of chimney gases without wasteful excessive air admission minimizes coal consumption. The ending of the war has not changed the conditions of boiler operation. It is fully as imperative to save fuel now as it was while the war was on.

In summing up the whole matter of fuel conservation, it is highly important not to overlook what may appear to be the small matters, for example it has been found that scale only 1/50 in. thick on the boiler tubes often means a loss in heat transference of 9.4 per cent with the consequent additional cost for extra fuel. Again, the pressure continually dropping means only extra work for the fireman, sweating away with shovel and slice bar to hold the load, and perhaps a job cleaning the tubes every few days. To a trained observer, however, it may indicate conditions that no amount of tube cleaning will remedy, as hot gases short-circuiting through leaky baffle walls, cold air sweeping in through myriads of tiny cracks in the setting, clinker pitted, slowly cleaned fire boxes, condensation in the steam lines, improper manipulation of dampers, improper care and adjustment of heating systems. All these conditions can be corrected by giving them the attention they deserve.

The Diesel Engine in Railroad Service

May Soon Become an Important Factor
In Heavy as Well as Suburban Traction

THE following article comprises an account of the extensive service which Diesel engines are performing in suburban passenger service in Sweden and a short outline of the possibilities of this form of prime-mover in heavy traction. We are indebted to a translation from Le Genie Civil of October 16, 1920, for the following description of the Diesel-Electric cars designed for suburban passenger service in Sweden together with a report of tests which have been conducted indicating a very economical fuel performance for these cars.

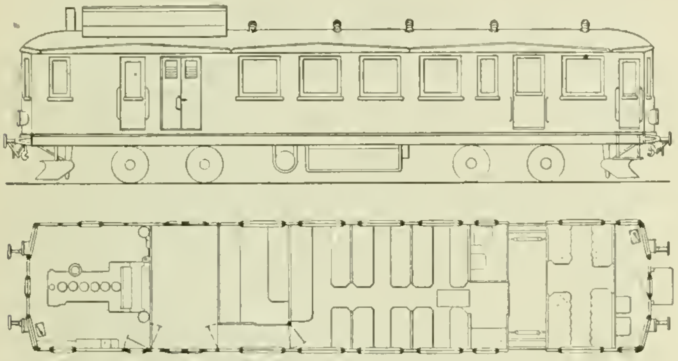

Fig. 1—Diesel Engine Composite Car

The second part of this article dealing with the broader phases of the Diesel locomotive as applied to heavy traction is contributed by Heinrich Schneider of Baden, Switzerland, who has made a close study of the Diesel locomotive for several years and has designed a number of improvements to this engine. In writing this part of the article it was the intention to outline briefly recent developments in the Diesel locomotive and draw particular attention to the great possibilities for the development of the Diesel locomotive in this country on account of its superior efficiency.

Diesel-Electric Cars on the Swedish Railways

Gasoline-Electric Motor engines have been studied for a certain number of years with a view to taking the place of motor engines or steam engines in surburban service. Although, up till now, this class of car is not widely distributed, it is nevertheless not without interest, especially in countries which are rich in liquid fuel, and its use may even be considered for traction on certain lines, like the trans-African lines, where coal and water are lacking and where electrification by means of overhead wire would incur expenses out of proportion to the traffic to be expected at the commencement.

Amongst the motors which may be installed on motor-engines of this class, with electrical transmission between them and the axles, the Diesel motors, which are today being extensively constructed in all industrial countries, offer the well known advantages of strength and economy which have caused them to be adopted on board submarines and numerous vessels. It is desirable, therefore, to give some consideration to various types of motor-engines of this kind, called for the sake of convenience "Diesel-electric," that have been running for some years on several lines of small Swedish railway companies.

There were no less than four different types, furnished with successive improvements, of these motor-engines working in Sweden between 1913 and 1917, which continued to run as long as it was possible to obtain the petroleum oils required for their motors. Moreover, they recommenced their service as soon as this period of scarcity was over. A statement of the characteristics of these cars will be found in the accompanying table. Each of these types includes a Diesel motor with six (or even eight) cylinders, direct connected to a dynamo which provides current for two motors mounted on the axles nearest the center of the car, or on those which are furthest from the Diesel motor.

In the first type, (Fig. 1), one end is arranged as an engine room with place for the engine-driver; then comes a baggage compartment, a postal compartment, a third class compartment (31 seats), a toilet, an entrance hall, a small second class compartment (10 seats), and finally a motorman's compartment for directing backward running. The second type differs little from the first, but it is lighter. Fig. 2 gives the plan of the third type, in which the Diesel motor is fitted in the middle of the car, while the two ends of the car are occupied by freight compartments or for postal service, and by the two motorman's compartments. Here the axles are independent, while the fourth type, in which the body of the car is similar to the foregoing, is mounted on two trucks, each of which carries a motor. The distribution of the loads is here symmetrical with reference to the center of the car. All the cars were supplied by the Générale Electric Company of Vasteras (Sweden) and the motors by the Atlas-Diesel Company. The following description specially concerns the third type, but the others only differ in the various disposal of the parts.

Diesel Motors

Some Diesel motors are 75, others 120 horse power. The first have six cylinders in line, the others six cylinders in V, and have speeds respectively of 550 and 500 revolutions per minute. Fig. 3 represents a 160 h.p. motor having eight cylinders. The crank shaft is completely enclosed in a gear-box which supports the two rows of cylinders inclined at 40 deg. The compressor for the injected air is worked by a crank at the end of the main shaft. The cylinders and yoke are cast in one piece. The valves are arranged in boxes which may be taken apart. The two opposite cylinders are slightly staggered in order to avoid the complication of forked connecting rods.

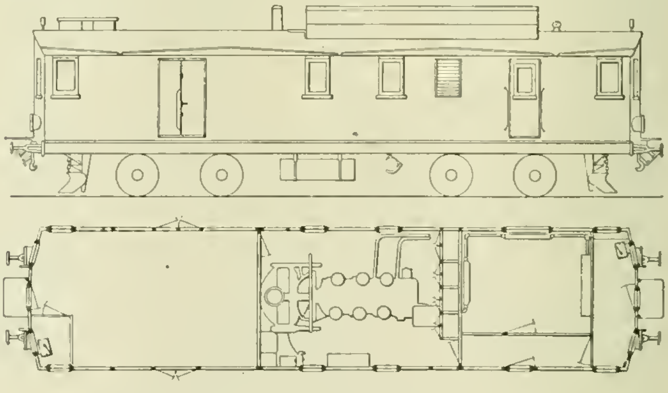

Fig. 2—Diesel Engine Express Car

The oil fuel is passed to the valves by a single pump, passing through distributors which allow any cylinder to be stopped. The regulation of the pump's output is effected by

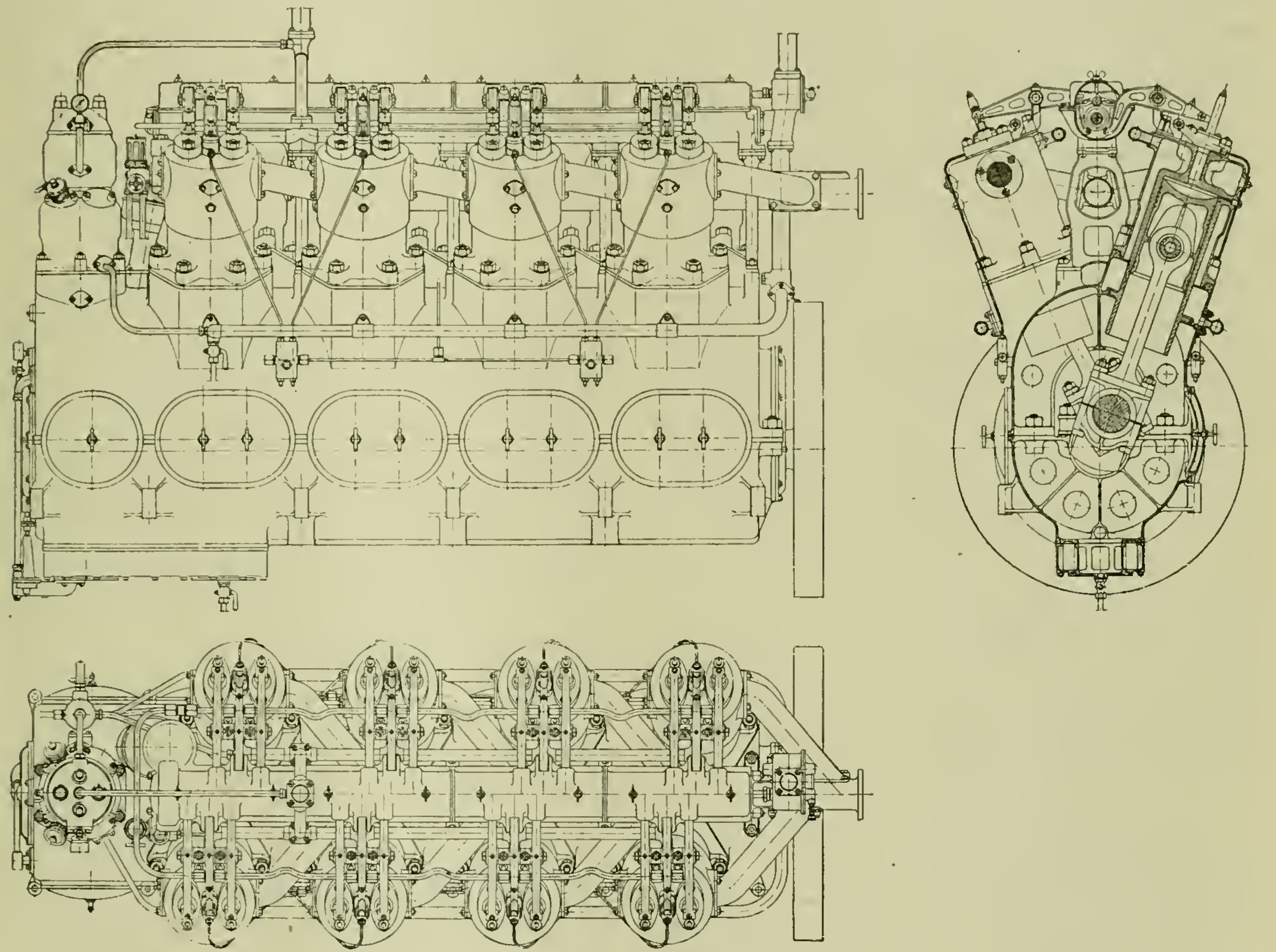

Fig. 3—160 H.P. Diesel Engine Designed for Railway Service

a regulator which acts on the pump. The fuel is injected by air compressed to about 60 atmospheres, furnished by the compressor. As this compressor does not give any air until after it is started, there are reservoirs of air which are filled automatically while the motor is in motion. The burnt gases are carried by a collector to an exhaust box and come out above the roof of the car. The cylinders and the compressor are cooled by water circulated by a pump mounted on the end of the distributing shaft. This water is cooled in a radiator placed on the roof. In order to prevent the water from getting too cold, a wooden frame may be placed around the radiator, on which a canvas is stretched. At each end of this frame doors are placed which can be opened from inside the car to regulate the temperature of the water. It is possible, also, in winter, to let the water pass into the radiators of the car, for heating purposes.

The motor is oiled by means of a pump which takes the oil under pressure to all the bearings. Before returning to the pump this oil passes through a filter with a radiator, placed under the car, in order to cool it. Reservoirs for the water and the oil fuel are fitted under the ceiling of the car. They are filled by means of outside joints and hand pumps placed in the engine room.

The motor is set in motion electrically, by means of a storage battery placed below the car. At this time the dynamo works as a motor, and all the necessary connections are made automatically by turning the handle of the controller in the driver's cabin. On the motor is fitted a small compressor which gives air at approximately six atmospheres for the brakes, signals and distribution of sand. The following are the results of trials of the motor of a car in 1916:

Bore of cylinder: 200 millimetres.
Stroke: 240 millimetres.
Fuel: Texas oil.

	Trial No. 1	Trial No. 2
Duration of trial (minutes)	44	44
Load	100 per cent	110 per cent
Revolutions per minute	500	495
Horse power	120	132
Consumption of oil:		
Total (grams)	16,900	
Per hour	23,040	
Per horse power hour	192	
Pressure of air injection (kg. per sq. cm.)	56	

Electrical Equipment

The direct connected dynamo delivers its power direct to motors mounted on the axle, so that the whole power of the motor can be utilized no matter what the speed of the car. The dynamo is mounted on the same frame as the Diesel motor and is driven by means of a flexible elastic coupling. The dynamo gives a continuous current, the tension of which varies between wide limits up to about 550 volts. It has eight poles, and is furnished with commutation poles with excitation shunt and series windings (the latter is only in circuit when the generator is working as a motor, for starting the Diesel motor by the storage batteries).

The two traction motors are series motors, with commutation poles. They drive the two center axles by means of spur wheels. Their frames are completely closed, and divided into two halves, the lower of which can be turned down on a hinge; in this way the interior of the motor can be examined without raising the car. The motors are fixed on one side by two bearings on the axle; on the other side the spring suspension allows the motors to follow the movements of the axles. In case of one motor breaking down, the driver can put it out of action from his seat and continue with the other.

Tests have shown that a 40-ton train hauled by a car of the first type, attains the following speeds:

On the level....................miles per hour	33
With a gradient of 0.3 per cent....................	24
With a gradient of 0.6 per cent....................	17
With a gradient of 1 per cent....................	12

With a car of the second type, with the same motor power, but on a narrow gage, rather higher speeds are obtained. Types 3 and 4 are furnished with motors which are more powerful and intended for heavier trains.

In the motorman's compartment are placed all the instruments necessary for driving, applying the brake on the car and controlling the machinery. The controllers have two drums, one to change the direction of running and the other to regulate the speed of the car. The direction is changed with the Diesel motor at rest. The drum for changing the speed controls the starting of the Diesel motor, the connecting of the electric motors, and the variations of speed.

Under these conditions, the car is easily driven. On starting, the handle for changing the direction is turned as desired; the safety knob is depressed, and the handle for changing the speed is turned to the first notch, at which moment the Diesel motor is set in motion. At the second notch the connections for setting the storage batteries in action are cut; at the third notch the car starts. By continuing to turn the handle the voltage of the dynamo is increased, and therefore the speed of the car. On stopping the safety knob is released in order to stop the Diesel motor, and then the handle is moved back to the starting position. When the motive power is not required, in going down hill for instance, or when the train is at rest, the Diesel motor does not revolve, but it starts instantly when necessary; this, of course, causes a saving of fuel and lubricating oil, diminishes the wear of the machinery and does away with vibrations while the car is standing still.

The constant voltage current required for starting the Diesel motor and for lighting, is furnished by a storage battery under the car. This battery charges itself automatically during the running; it can also be charged while the car is at rest, by proceeding in the same way as for starting, but after having placed the switch at "charge" the traction motors are, in this case, cut off.

Results of Tests

In February, 1919, the following figures were obtained on a train comprising a Diesel electric motor engine of Type III, a passenger car with two trucks and a passenger car with two axles. There were 139 passengers in the train:

Weight, motor car	32.8 tons
Weight, passenger car with trucks....................	23.8 tons
Weight, car with two axles....................	16.0 tons
Total	72.6 tons
Weight, 139 persons (at 165 lb.)....................	10.4 tons
Total	83.0 tons

	Stockholm-Vasteras	Vasteras-Stockholm
Distance ....(miles)	69	69
Number of stations stopped at....................	8	8
Time during which car was running..........	3 h. 1 m.	2 h. 55 m.
Time during which motor was running..........	1 h. 59 m.	2 h. 11 m.
Ratio of these times..........(per cent)	65.5	74.5
Average speed per hour..........(miles)	23	24
Total consumption of fuel..........(kilogr.)	47.5	46.5
Consumption of fuel per 1,000 ton-miles,	18.9	18.6
the average weight of the train being 83 tons ....(pounds)	18.9	18.6
Density of oil fuel....................	0.815	0.815

Consumption of fuel reported during two weeks' working:

	1st week	2nd week
Weight of train....................(tons)	61.5	81.0
Consumption of fuel per ton-kilometre....(grams)	6.11	5.38

Statistics from the service of six cars of 75 h.p., which were in use during the years 1913 to 1917, gives rather interesting information, as these statistics cover more than 650,000 kilom. In 1917, these cars were for the time being stopped on account of lack of fuel, but at the end of 1919 the distance covered was more than one million kilometres, which corresponds to a daily trip of more than 600 kilom. during four years and a half. The following are the results of these statistics:

Total distance covered....................(kilom.)	658,889
Number of days in use....................	4,380
Distance covered without trailer....................(kilom.)	395,664
Distance covered with trailer....................(kilom.)	263,225
Number of kilometres per day....................	150
Number of ton-kilometres....................	22,875,690
Average weight of train....................(tons)	34.8
Consumption of fuel per ton-kilometre..........(grams)	9.65
Consumption of lubricating oil per kilometre....(grams)	11.95

These results are very encouraging, especially if compared with those obtained with other oil-electric vehicles, by which the specific consumption was generally at least double. On account of the low over-all efficiency of steam engines and of the high price of coal in Sweden, it has been estimated that, under the same conditions, a Diesel-electric train only expended about 6 per cent as much in fuel as a steam train. This has led to the construction of motor-engines with motors of 160 and even 250 h.p. A 250 h.p. motor will draw a train carrying 300 passengers.

Direct Drive Needed for Heavy Traction

In the discussion of the Diesel locomotive contributed by Heinrich Schneider, the author advocates the adaptation of the submarine type engine for locomotive service, with direct drive. The following is an abstract of Dr. Schneider's views:

For the highest economy the Diesel locomotive will have to be given serious consideration in the near future. In Europe mechanical engineers are quietly, though indefatigably working at the perfection of this style of locomotive. Owing to the wear and tear, the destruction during the time of war and the falling off in the production which still continues in several countries, the world is faced with the necessity for great renewals in all rolling stock, particularly locomotives. The increase of wages as well as the high prices for coal and oil necessitate that materially greater attention be paid to the economic consumption of fuel by locomotives than has been heretofore required.

Each style of locomotive has its special field of activity, and none will predominate everywhere. For street cars nothing but electric propulsion can be considered. However, the steam locomotive will be chiefly employed in thinly populated and mining districts, while the Diesel locomotive will find its greatest sphere of activity in poor coal districts. There is an unlimited field of activity for the Diesel locomotive in those countries and parts of the world with long railroads, scattered stations and low traffic density, such as South America, Africa, Asia, as well as India, China, Russia, etc., which are not highly industrialized, sparsely populated and without large coal deposits.

In various countries there is at present the desire to electrify all railways. However, this is only recommended for countries which like Switzerland can utilize easily exploited water power. In other countries where electric power is to be generated from coal or oil, expensive electric power stations, collector installations, etc., and very expensive electric locomotives are required for the electric railway installations. Such installations, can, therefore, only be considered for countries of highly cultivated industry and large population as in Europe and parts of the United States, while for all other countries the building cost and working expenses of these installations are very extravagant. It is here that the Diesel locomotive will be found to be greatly superior to electric railway traction.

As with the automobile for which electric propulsion has answered in city traffic only, propulsion by combustion engines has proved far superior in all other departments.

The construction of the Diesel locomotive has been tried for many years. Diesel, himself, in describing his motor in 1897 pointed out the following advantages offered by the Diesel locomotive: "The concentration of great capacity in a locomotive requires, for economy, long and heavy trains. With the oil motor locomotive, however, the greatest economy would be obtained with short and frequent, as well as separate passenger, freight and goods trains." Scherl with his single rail railway, with frequent light and high speed trains points out the same thing.

No material progress has been made for the last 30 years in the development of the steam locomotive as to the utilization of heat. It is only by the insertion of the superheater that a nominal improvement has been achieved in the utilization of fuel. The rapidity with which all railway companies have seized upon this innovation shows their eagerness to improve the economy. The superheater increased the utilization of fuel by 10 to 20 per cent while the Diesel locomotive allows of an increase of the utilization of fuel of upwards of 200 per cent compared with the exhaust steam engine. There are, however, some firms in central Europe at present building experimental locomotives with steam turbine drive and condensation installation and this may bring improvement in the consumption of fuel compared with the exhaust steam locomotive engine.

If we but view the construction of marine engines and motor cars which likewise forms a part of the system of communication, we find that the progress of railways has conspicuously lagged. It is to be expected that in the course of some years a considerable development will occur in this field. About 12 years ago the first, and so far the only, Diesel locomotive was turned out in Europe, displaying on its trial trip, a capacity of about 1,000 h.p. and a speed of 100 km. (62 miles) per hour. Trial trips were made with this locomotive from Berlin, and it is to be regretted that nothing was published in regard to the result. For the purpose of starting there was an auxiliary compressor of ample capacity installed on this locomotive. However, it appears that the difficulties in starting were nevertheless so great as to have prevented the construction of further Diesel locomotives of this description. To overcome the starting difficulties arising out of the direct propulsion by the Diesel locomotive, electric transmission of the oil engine output to the driving shafts has been suggested. This arrangement, which was at first intended for narrow gage railways only, has found employment in benzol and oil dynamo motor cars, Important firms have of late developed this construction so far that it can already compete with the electric motor car and the steam locomotive.

In the matter of trunk line locomotives of highest capacity, however, there can be no talk of electric transmission since electric motors would assume such large space and weight as to require a whole motor car to themselves. The direct transmission of the Diesel engine is considerably cheaper and more simple.

The great possibilities of the Diesel locomotives have been recognized for a long time past, though almost unsurmountable difficulties have opposed their construction. These, however, may now be looked upon as having been overcome owing to the remarkable evolution of oil engines during recent years. The following are the conditions that must be met in the construction of reliable Diesel locomotives:

1—A reliable, reversible and high speed Diesel motor is required.

2—Ability to start the train by means of an oil motor, bearing in mind that oil motors will not start under load.

3—Special construction must be devised for the accommodation of the motors and driving mechanism.

It is one of the objects of this article to state what has been accomplished toward meeting these several requirements. In the approved engine of the submarine boat we find the actual construction of the locomotive driving engine ready for use. Cylinder dimensions, stroke, and rotation figures are almost the same. Both valve motion and governing apparatus remain the same, although the labor of adapting this to the railway service is not to be underrated. The starting difficulties have been solved by a number of recent inventions, only a portion of which have been made public.

The greatest difficulty in regard to starting has been overcome by the insertion of liquid gears of two different types. By the employment of liquid and mechanical gears the limit put upon the direct driven locomotive by the number of revolutions, the stroke and piston pressure is extended. A particularly hopeful design may be mentioned in which the starting apparatus consists of but one rotating part, so that a considerable increase in speed is possible. Furthermore, there is a design which with some slight alterations will make it possible to use the submarine boat engine for locomotives.

America, as the richest oil producing country in the world, with her highly cultivated industries, her great financial resources and her tremendous railway system is the very country for the Diesel locomotive. It is therefore difficult to realize why America has hitherto paid so little attention to the construction of oil engines. As we may presume that the reason for this lies in the fact that, until the transformation of the economic state of things brought about by the war, there was a superfluity of cheap fuel, so that the economical oil motor met with delayed consideration in America as compared with Europe where the high prices for combustibles gave rise to a much earlier search for a more economical engine.

At present strenuous efforts are being made in the states to replace the steam drive in shipbuilding by the oil motor drive for which the large marine oil engines must be developed. The steam locomotive is much less economical than the stationary or marine steam engine or turbine and yet these have been replaced by the oil engine for some time. If America wants to extend her dominating position in industry to the construction of heat engines, she will be obliged to take up the construction of Diesel motors and oil motor locomotives.

Central Europe engaged vigorously in the construction of the Diesel motor locomotive before the war but all such endeavors were interrupted by the outbreak of hostilities. Although Germany is economically overthrown, there are several influential German firms who are energetically pushing the construction of oil motor locomotives. Hence Germany appears to keep up the lead in the construction of combustion engines in spite of the breakdown she has suffered. It is high time to get rid of prejudices concerning the oil motor locomotive because of its apparently insurmountable difficulties, seeing how similar mistaken ideas were entertained for so many years about the Zeppelin airship. The oil motor with a capacity equal to that of the locomotive engine is already available. Owing to the issues of the war, the world enjoys the benefits of the experience with the construction of the submarine oil engine, so that America is now in a position to utilize this.

That the evolution of the Diesel locomotive engines will take years is considered a matter of course by every authority, but we should commence all the sooner with studies and preparatory labors for the oil motor locomotive engine puts the highest claims on the engineering art. The conclusion to be arrived at from these observations is that there are no longer any insurmountable technical obstacles in the way of the construction of the oil locomotive and that there is an economical necessity for substituting the far superior oil locomotive for the steam locomotive.

Controversy Before Labor Board Continues

Situation Forcefully Presented by Atterbury; Brotherhoods Fail to Secure President's Intervention

THE immediate abrogation of all national agreements, the remanding of the question of rules and working conditions to negotiation between each carrier and its own employees, the re-establishment of the agreements, rules and working conditions in effect on December 31, 1917, and the right to pay unskilled labor not less than the prevailing rate of wages in the various territories served by any carrier, were requested of the Railroad Labor Board on January 31 by General W. W. Atterbury, vice-president of the Pennsylvania and chairman of the Labor Committee of the Association of Railway Executives. The request was accompanied by a vigorous statement of the present precarious financial position of many of the carriers, General Atterbury predicting bankruptcy for many and a resulting financial panic unless steps are taken immediately to cut needlessly huge wage payments and thus bring operating expenses into proper relation to the operating revenues now accruing under increased freight and passenger rates.

At the close of General Atterbury's statement, which has been generally quoted in the press, H. T. Hunt, a member of the public group on the Board, and Judge R. M. Barton, chairman of the Board, suggested that representatives of the railroads and the employees meet to formulate means, if possible, to avert the disaster predicted by General Atterbury. To this suggestion the latter replied that negotiation would be futile because of the dissimilarity of the views of the executives and of the employees and because of the necessity for immediate action.

Chairman Barton then stated that the requests made by General Atterbury would have to be considered in executive session but, in reply to a question of B. M. Jewell, president of the Railway Employees' Department of the American Federation of Labor, he said that representatives of the employees would be heard before any action was taken by the Board. Mr. Jewell and other representatives of the employees present at the hearing declined to reply to Mr. Atterbury's requests or to make any statement at that time. Mr. Jewell, however, stated that he would prepare a reply on behalf of the employees to be presented to the Board later.

General Atterbury's statement was made after the Labor Committee of the Association of Railway Executives had been in session at Chicago for three days discussing the present labor situation and formulating plans for the restoration of conditions under which an honest day's work for an honest day's pay might be rendered by railway labor.

Various of the "independent" railway organizations have been fighting since the beginning of the present hearings for the right to present their views regarding national agreements independently. On February 2 the Board's decision on their petitions was made public, representatives of these organizations being granted the right to be heard in the present case despite the opposition of the larger brotherhoods who have maintained that the members of the independent organizations are adequately represented by them.

Appeal to President Wilson

The vigorous stand taken before the Railroad Labor Board by General W. W. Atterbury, vice-president of the Pennsylvania and chairman of the Labor Committee of the Association of Railway Executives, against the continuance of national agreements brought forth talk of general railroad strikes, charges and answers. The matter finally reached President Wilson, whom representatives of the labor organization petitioned for the presentation of the issues involved to Congress and representatives of the carriers followed with specific answers to the charges made by the labor leaders.

The executives of the brotherhoods filed long telegrams to the President, declaring that they did not believe that the carriers were in the financial condition outlined by General Atterbury and attacking the latter for "violating all decent proprieties, disregarding the Transportation Act and flouting existing agencies such as the Interstate Commerce Commission and even Congress itself."

"General Atterbury's policy," the telegram charged, "is to disrupt labor unions, turn public opinion against the employees and place wages on a previous basis so that railway profits might be enhanced when prosperity returned."

In support of these contentions, the telegrams reiterated the charges of mismanagement and control by a New York banking group which have been made repeatedly during the past month by various labor leaders and which are under investigation by the Interstate Commerce Commission.

The charges made in the employees' telegram were immediately answered by T. DeWitt Cuyler, chairman of the Association of Railway Executives, in a telegram to the President.

President Wilson on February 6 replied to the telegrams addressed to him by the railroad labor leaders and the railroad executives at Chicago last week, declining to interfere in any way, during the last month of his administration, in the controversy between the railroad executives and the labor leaders regarding the abrogation of the national agreements. The labor leaders had asked for a Congressional investigation of the railroad situation but the President in his reply indicated confidence that the case is now in the hands of the proper tribunal and he therefore referred the copies of the telegrams to the board and to the Interstate Commerce Commission for such action as they may deem wise. The President's action was taken on recommendations made to him by John Barton Payne, director general of railroads, to whom the telegrams were submitted on their receipt last week.

B. M. Jewell, president of the railroad department of the American Federation of Labor, declared that the president's message was a complete vindication of the stand taken by the unions in that it "makes it perfectly clear that the board should confine its jurisdiction strictly to the controversy as to wages and working conditions, leaving financial matters to the Interstate Commerce Commission."

Atterbury Replies to Jewell

W. W. Atterbury, Chairman of the Labor Committee of the Association of Railway Executives, issued a statement on Tuesday in reply to the assertion of B. M. Jewell, representing the employees, that President Wilson's reply meant that the Board would consider only wages and working conditions, and that financial questions would be considered by the Interstate Commerce Commission.

"His hope that the financial results of existing rules and working conditions can be hidden from either the Labor Board or the public will not be realized," said Mr. Atterbury's statement.

"He would maintain indefensible waste and inefficiency even at the cost of destroying the earning power of the railroads or of compelling them to go to the Interstate Commerce Commission for still higher rates.

"The producers and consumers of the country cannot support Mr. Jewell's program. It requires no conspiracy against union labor to explain their attitude or mine. The railroads are struggling to regain the reasonable productivity of a considerable part of their employees, now seriously impaired by the rules and working conditions coming over from the war. That conspiracy is the conspiracy of the entire country."

This reply was followed in turn by the issuance of two statements by General Atterbury in both of which he presented evidence to sustain his contentions made before the board on January 31.

While both the carriers and the employees were publicly defining their respective positions in this controversy, Mr. Jewell petitioned the Labor Board for additional time in which to prepare his reply to General Atterbury's requests. This petition was opposed by E. T. Whiter, who presented a letter on this subject written by General Atterbury and vigorously opposing any further extension of time. After consideration in executive session, however, the Board granted Mr. Jewell's request and February 10 was set as the date upon which he would be heard.

Mr. Jewell in the interval granted him to prepare a reply to General Atterbury, repaired to New York and retained Frank P. Walsh, the labor counsel, and W. Jett Lauck, economist, and a battery of publicity men to assist in bringing a conspiracy charge before the Board. Mr. Jewell planned to ask for postponement of consideration of the question of national agreements and for a hearing upon the evidence the unions wished to present in support of their charge that railway executives and financiers have conspired to re-establish autocratic control of the transportation industry.

Chairman Barton in opening the session on February 10 read a resolution passed by the Board which prohibited the presentation of such evidence and which pointed out that the Interstate Commerce Commission is the proper body before which to present such charges.

Board Denies Immediate Abrogation of National Agreement

The Board's resolution also denied General Atterbury's requests for immediate abrogation of the National Agreements and for the right to pay unskilled labor the prevailing rate in the territory where they are employed. The resolution, after reciting the history of the present case, stated that the Board must hear all of the evidence before ruling on the National Agreements and that it was powerless to grant General Atterbury's request regarding unskilled labor because the matter has not been brought before the Board according to the procedure outlined by the Transportation Act.

After a short recess Mr. Walsh began a presentation on behalf of the employees. He confined his remarks to replies to General Atterbury, attacking the Pennsylvania and charging that his statements are misleading. That the railroads are in a precarious financial condition was denied by Mr. Walsh, although the statement was not accompanied by proof.

B. M. Jewell, appearing before the Railroad Labor Board at Chicago on February 17 in the resumption of hearings in the controversy over National Agreements, asked that the Board take the following steps immediately:

"First: That the Board refer the National Agreements which are now before it to a joint conference of the representatives of the railroads and of the labor organizations with the recommendation that their disagreements be adjusted by negotiation as soon as possible—the Board agreeing to pass immediately upon any points of difference which may arise from the negotiations.

"Second: That the Board request the representatives of the railroads and representatives of the labor organizations to meet the Board in conference to consider the establishment of boards of adjustment as contemplated by the Transportation Act.

"Third: That in reply to Mr. Atterbury's notice to the Board and his subsequent letter to the chairman advising him that he contemplates filing a flood of individual complaints to reduce the wages of unskilled employees, the Board recommend to Mr. Atterbury that he meet in general conference with the representatives of the employees affected so that the existing General Agreements will not be impaired and the matter brought to the Board in the form of a single complaint."

Mr. Jewell declared his constructive proposals were brought forward with the following objects in view:

"1. To insist upon the fundamental principle of collective bargaining which is now the real issue before the Board in our pending cases.

"2. To expedite the cases which otherwise will absorb a vast amount of time and effort.

"3. And to restrain Mr. Atterbury and the railroads from preventing the proper functioning and destroying the effectiveness of this Board by flooding it with a large number of individual complaints which it cannot handle."

Mr. Jewell also asked that a conference be called immediately between the railroad labor chiefs in Chicago and the members of the Association of Railway Executives.

Executives Denounce Conference Plan

The Association of Railway Executives at a meeting on February 18 unanimously adopted the report of its labor committee and passed resolutions refusing to enter into national conferences suggested by the employees as a means of settling differences over wages of unskilled labor and working conditions.

The executives denounced the employees' proposed conferences as a plan by labor leaders to bring about nationalization of the railroads.

The committee report pointed out that the opposition made by the roads to the National Agreements and the position taken today was not to be construed as an attack on labor organizations themselves.

"The railroads are confronted with this situation—while endeavoring to escape from one set of rigid and uniform rules and working conditions inherited from the war they are met with a new demand, which, if acquiesced in by the Labor Board, would deprive individual carriers of direct negotiations with their own employees."

Replying to statements by labor leaders that the railroads' suggestion to abrogate the National Agreements was part of a plot originating in Wall street to break down the labor organizations, the report said:

"The record demonstrates that the railways have acted throughout independently, primarily in their own interest, but also in the interest of the shippers and farmers."

Atlanta, Birmingham & Atlantic Case

The efforts of the Atlanta, Birmingham & Atlantic to secure authority to reduce the wages of its employees below the rates set by the Board's decision of last July have attracted much attention, the case coming before the Board simultaneously with the introduction of General Atterbury's evidence in the National Agreements hearings outlining the precarious financial condition of many of the carriers. The case is also viewed with interest inasmuch as the rulings of the Board in this case will undoubtedly establish precedents which will serve to guide the Board, the carriers and the labor organizations in preparing, submitting and arguing future cases of this character. It is not, however, considered in the light of a test case by railway executives.

The Atlanta, Birmingham & Atlantic had ordered a cut in the wages of its employees effective on February 1 because of its inability to meet its operating expenses. Despite drastic reductions in working forces and in train service the carrier was losing about $100,000 a month. The employees objected to the wage cut and, when conferences were held between their representatives and representatives of the carrier, a controversy arose as to whether the wage reduction could be made effective, under the terms of the Transportation Act, pending a decision by the Labor Board. The representatives of the carrier held that the wage cut was unavoidable and would have to be made on the date announced even though the Board had not reached a decision on the employees' appeal. The employees held that the existing rates of pay should be continued until the Board had made its ruling.

When the case came before the Labor Board on January 25, the employees refused to present evidence in the case until the Board had instructed the carrier to rescind its wage cut order. The representatives of the carrier after presenting voluminous evidence showing the financial condition of the road, held that they had not violated the spirit or letter of the Transportation Act in cutting their wages first and then coming before the Board. Subsequently the Board passed a resolution upholding the employees' contention and ordering the carrier to rescind its wage cut order.

Following the precedent established in the Atlanta, Birmingham & Atlantic case the Board issued an order on February 14 directing the Erie to rescind its recent order reducing track laborers' wages, re-establishing the seven-day week for train despatchers and deducting the January 31 earnings of telegraphers. The order was to have been effective on February 1.

Fatal Gasoline Explosion at Memphis*

On January 24, 1921, vapors from a tank car of casinghead gasoline on the Union Railway spur on Front street, Memphis, Tenn., became ignited and resulted in a blast that killed 11 people and badly injured 19 others. Probably 40 or 50 men, women and children received slight injuries from falling debris or from burns. The explosion wrecked an oil plant, levelled a block of frame buildings and broke window panes within a radius of five blocks, the estimated loss being $200,000.

Shipments of casinghead gasoline began about 10 years ago and the records of the Bureau of Explosives show this disaster to be the sixteenth serious accident that has resulted from the removal of the dome cover while interior pressure exists in the tank.

The gasoline contained in the car was a volatile product known as absorption gasoline with a gravity of 81.5 deg. Baumé, initial boiling point of 80 deg. F. and end point of approximately 360 deg. F. The car was spotted on Saturday, January 22, and the following Monday morning, January 24, a negro workman at the plant opened the tank car without relieving the pressure within. The pressure of vapors that existed in the car is not known although it has been said that the relief valves had been giving off vapors previous to this time. This statement has not been verified but probably there was a pressure of nearly 25 lb., at which the valves popped. The removal of the dome cover resulted in the sudden relief of pressure and gasoline vapor and liquid gasoline boiled out of the dome head in large quantities. The wind from the west in carrying these vapors across the street, mixed them with air and formed readily ignitable mixtures. The vapor became ignited by open fires in the frame buildings on that side of the street and instantly there was a terrific explosion which demolished every house on the west half of that block, as well as destroying buildings in the blocks north and east. This explosion was followed by a second and more muffled one which was made by the flame flashing back to the tank car where vapors issuing from the dome caught fire and burned as they came out. The damage on the west side of the track in the oil plant itself was due largely to the fire that followed. This fire caused the destruction of a garage containing four automobiles, the ruin of a warehouse of sheet iron construction and the loss of several hundred barrels of oil and grease stored therein. These drums of oil caused several minor explosions and, upon breaking, burned with intense heat.

To add to the danger of the fire, there were seven 11,000-gal. tanks filled with gasoline and kerosene, which stood opposite the garage in the oil plant, and five more tanks elevated against a concrete wall at the west side. A second car of absorption gasoline, spotted at the same time as the one which exploded, was vented and the escaping vapors burned. The storage tanks also were vented at the top with nipples enclosing wire gauze and as vapors formed and passed out of these vents into the air, they burned quietly. Neither the second tank car nor any of the tanks were damaged in any way. It is interesting to note that after the fire had been extinguished, the car from which the explosion originated was still about half full of gasoline. The car was damaged only slightly and the wooden foot boards were only partly burned.

The investigation of the accident showed that the colored employee, Andrew McKinley, removed the dome cover without paying attention to the positive directions on the dome placards pasted over the dome cover joint and cautioning that the dome cover should not be removed until after release of all interior pressure in the tank. When he succeeded in unscrewing the cover it was thrown into the air by interior pressure in the tank and a column of gas and liquid was forced vertically upward to a height estimated by witnesses to be about 100 ft. The dome cover contains vent holes under the flange and above the threads, the object of which is to make it impossible to completely unscrew it without evidence of interior pressure furnished by the noise of vapor escaping through these vents. Witnesses 100 ft. or more away from the car testified that a hissing noise of growing intensity was heard while McKinley was engaged in unscrewing the cover. This warning as well as the warning of the dome placard was disregarded.

The serious results of this explosion demonstrate once more the need for ceaseless vigilance in handling tank cars of gasoline or other volatile liquids which may explode. In handling gasoline, the Interstate Commerce Commission regulations require that a car, when loaded, must have a certain voidance above the gasoline. This voidance is to take care of any expansion of the liquid which may occur if it becomes heated in transit. Safety valves are provided which will relieve any pressure above 25 lb. within the car. These valves should always be opened before the tank car is unloaded. In case pressure develops, the car can be sprayed with water and the resultant cooling will condense the greater part of these powerful vapors, thus reducing the pressure measurably.

Another way to relieve the pressure is by leaving the valve open and allowing the gas to dissipate slowly. In addition, there are in the dome cover several holes above the threads which will allow the escape of vapors before the cover is entirely removed, thus warning a man when there is pressure within. In no case should the dome cover be removed until this pressure is relieved.

"Only about 9 per cent of the country's factories are properly illuminated," says Industrial Power. "Thirty-five per cent of our factories have not changed their lighting systems in five years, notwithstanding that the lighting art has been revolutionized during this time. In other words, 35 per cent of America's industrial plants are five years behind the times in a matter that may affect their output anywhere up to 35 per cent."

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*The account of this explosion is taken from a special bulletin issued by the Bureau of Explosives and the report of an investigation conducted by the Department of the Interior, Bureau of Mines.

Virginian Gondola Car of 120 Tons Capacity

120-Ton Cars Now in Service on the Virginian

Gross Load Behind Tender Increased from 7,950 to 13,200 Tons; First Application of New Six Wheel Truck

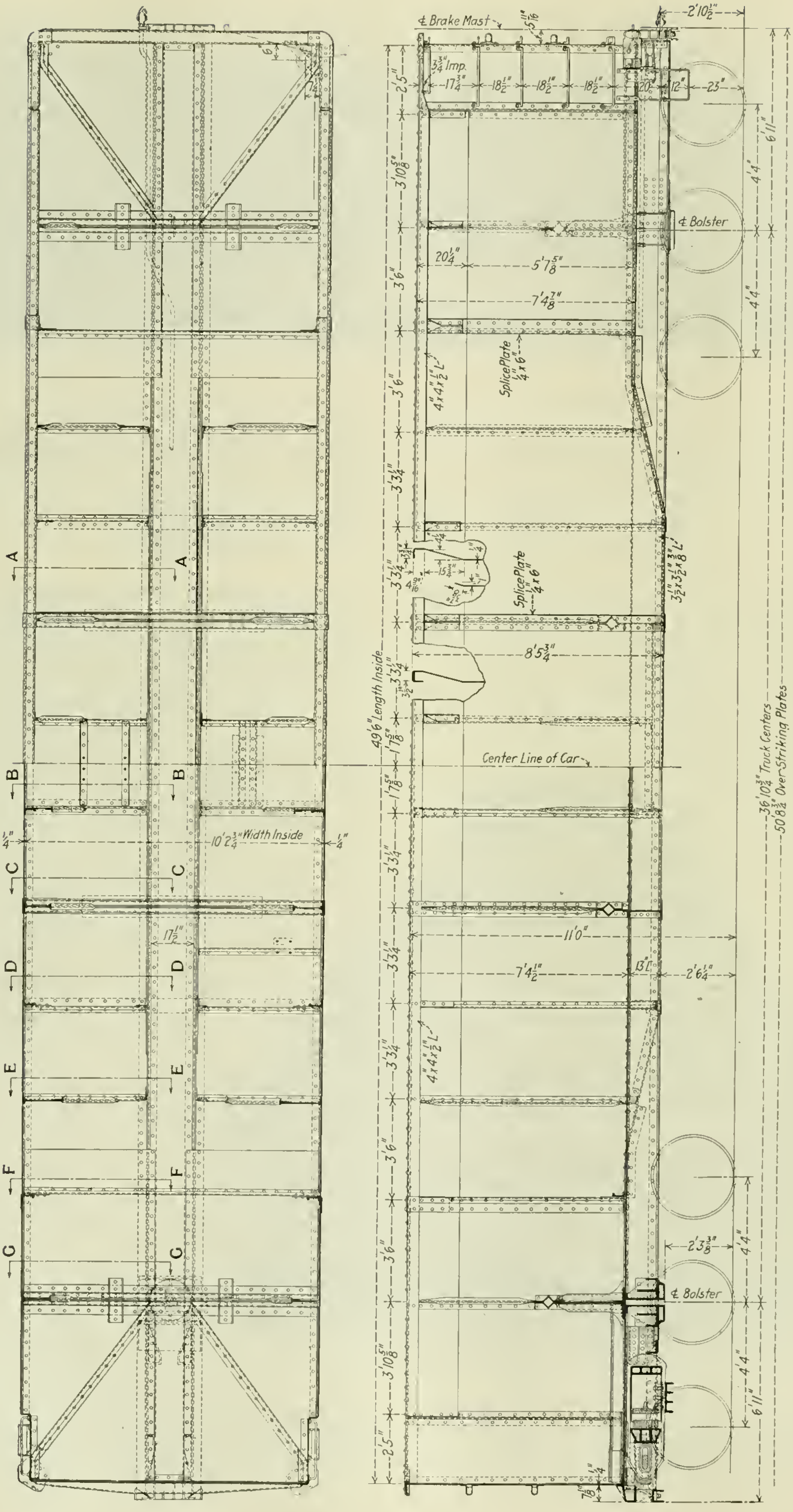
THE Virginian Railway has recently received from the Pressed Steel Car Company at Pittsburgh, 1,000 steel gondola coal cars of 120 tons capacity. This equipment is the heaviest in the history of transportation and is notable for two reasons: First, because it is the first instance where a large number of cars of such extremely high capacity have been placed in service, and, second, because the equipment has been developed especially to meet the operating conditions on the Virginian road.

Interior of the Car Body, Showing Gusset Side Stakes, Bolsters and Cross Bearers

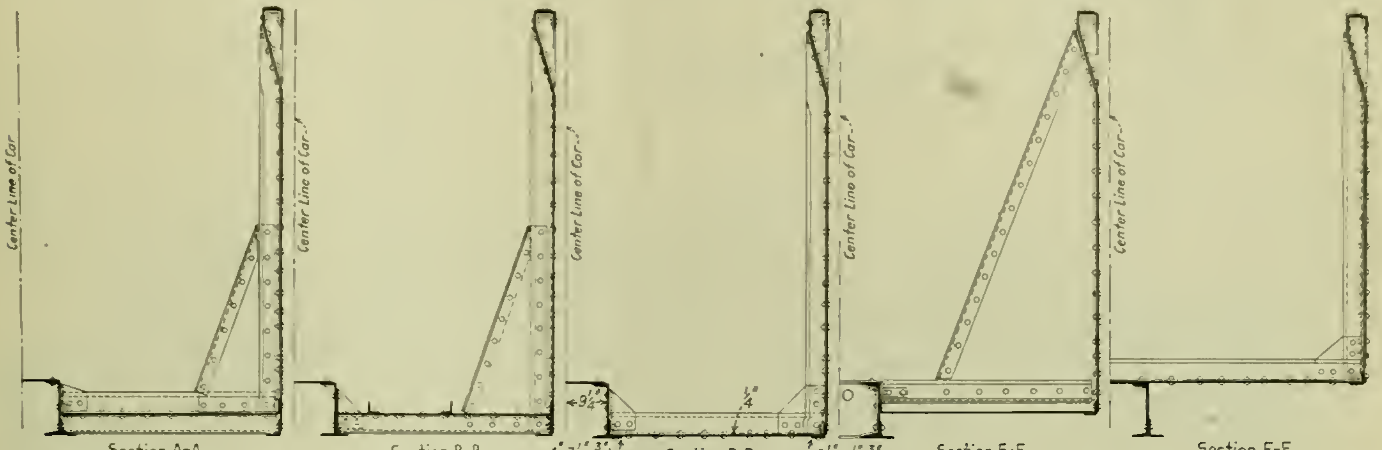
The circumstances that led the Virginian to go from the use of 55-ton cars to 120-ton cars are worthy of comment. Of the total traffic handled by the Virginian, 92 per cent is coal, moving to tidewater and inland points from mines west of Princeton, West Virginia, the greater portion of which moves to Sewalls Point pier, 342 miles from Princeton. The profile consists principally of slight descending grades; thus the tonnage that can be handled in a single train is limited over a large part of the line, not by the tractive capacity of the locomotive, but by the difficulty of securing proper operation of the air brakes in the handling of long trains on descending grades to avoid break-in-twos.

Since such a large proportion of the traffic consists of tidewater coal, the normal operation of the road depends upon the ability to dump cars promptly on arrival at the pier. In order to secure the maximum capacity of the pier duplicate unloading facilities have been provided. Two separate car dumpers, one handling a 55-ton car and the other two 55-ton cars, or one 120-ton car, dump into electrically operated conveyor cars. The conveyor cars from one dumper are drawn by a cable hauling system up an incline to the top of the pier, from which point they are moved by electricity to the proper chute and the coal dumped through by air pressure. The other dumper is served by an elevator that lifts the car to a track running over the pier pockets.

Under normal conditions the Virginian moves a large proportion of its traffic in its own equipment, consisting principally of gondola and hopper cars of 55 tons capacity and, latterly, 120 tons capacity. Two of the former cars can be handled on the two-car dumper, or one 120-ton car, from which it will be noted that the adoption of a car carrying

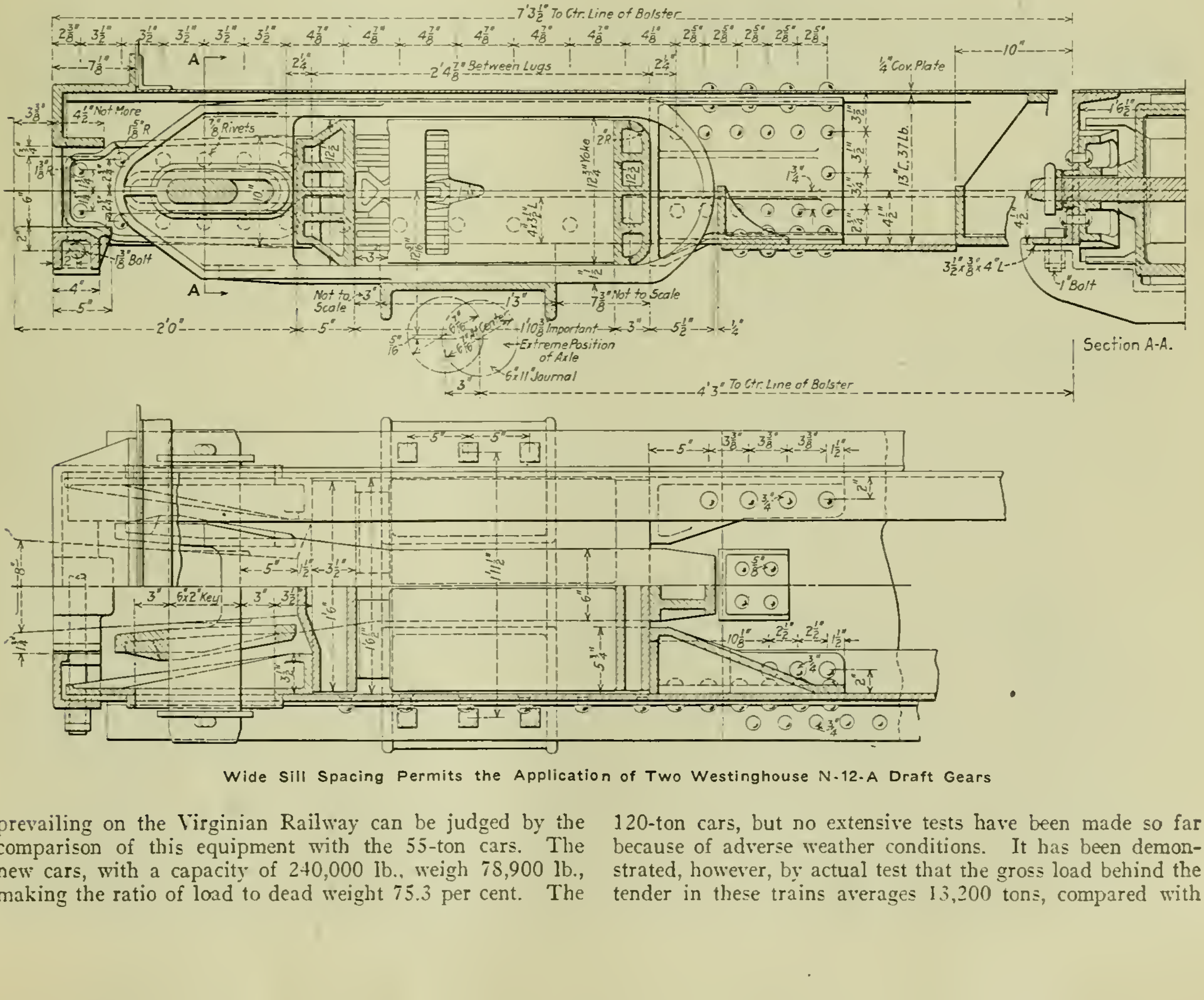


Plan and Side Elevation of the Body of the Virginian 120-Ton Car a less load would have the effect of reducing the capacity of the dumper and the efficiency of the pier. With this in mind, plans were made for the development of equipment having twice the gross weight of the 55-ton cars. In 1917 four sample 120-ton cars were placed in service to determine whether the use of such equipment would be practical and economical, and, as a result of these experiments, the order for 1,000 cars of this capacity was placed in the spring of 1920, immediately after the roads were turned over to the corporations.



Cross Sections of the Car Body

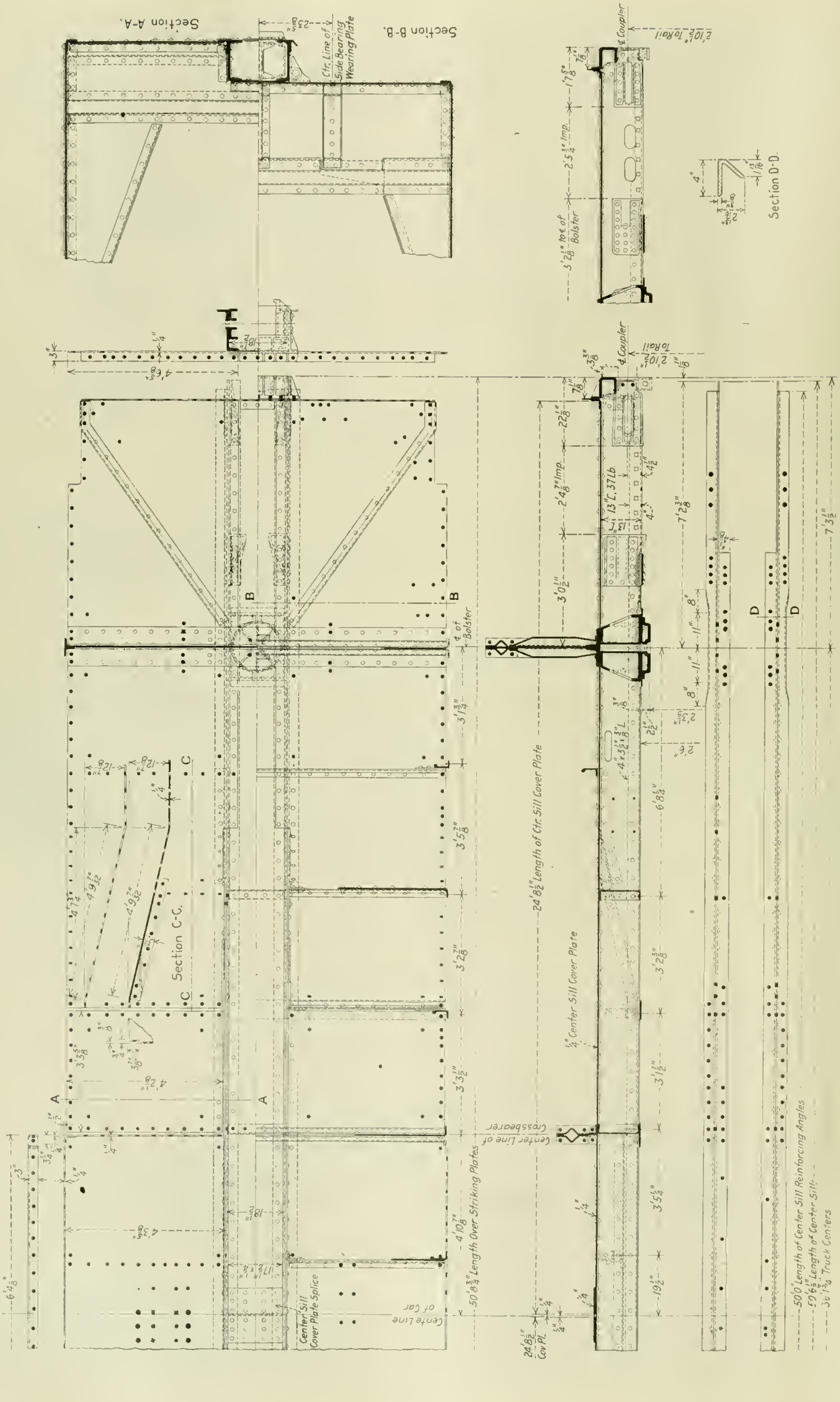
The advantages of the 120-ton car under the conditions prevailing on the Virginian Railway can be judged by the comparison of this equipment with the 55-ton cars. The new cars, with a capacity of 240,000 lb., weigh 78,900 lb., making the ratio of load to dead weight 75.3 per cent. The gondola and hopper cars, with a capacity of 60 tons, weigh 41,000 lb. and 44,000 lb., respectively, making the ratio 74.5 and 73.2 per cent.



Wide Sill Spacing Permits the Application of Two Westinghouse N-12-A Draft Gears

The 120-ton cars are 49 ft. 6 in. long inside, while the 55-ton hopper cars are 32 ft. 6 in. long and the gondolas 40 ft. long. Thus the gross weight per foot of length for the 120-ton cars is 61.7 per cent greater than for the 55-ton gondola, and 31.0 per cent greater than for the hopper. For a given length of train the net tonnage that can be handled in the larger cars is even greater.

It has been found entirely practical to handle trains of 120-ton cars, but no extensive tests have been made so far because of adverse weather conditions. It has been demonstrated, however, by actual test that the gross load behind the tender in these trains averages 13,200 tons, compared with



Details of the Underframe and Floor Construction, Showing Draft Arrangement for Westinghouse and Cardwell Gears

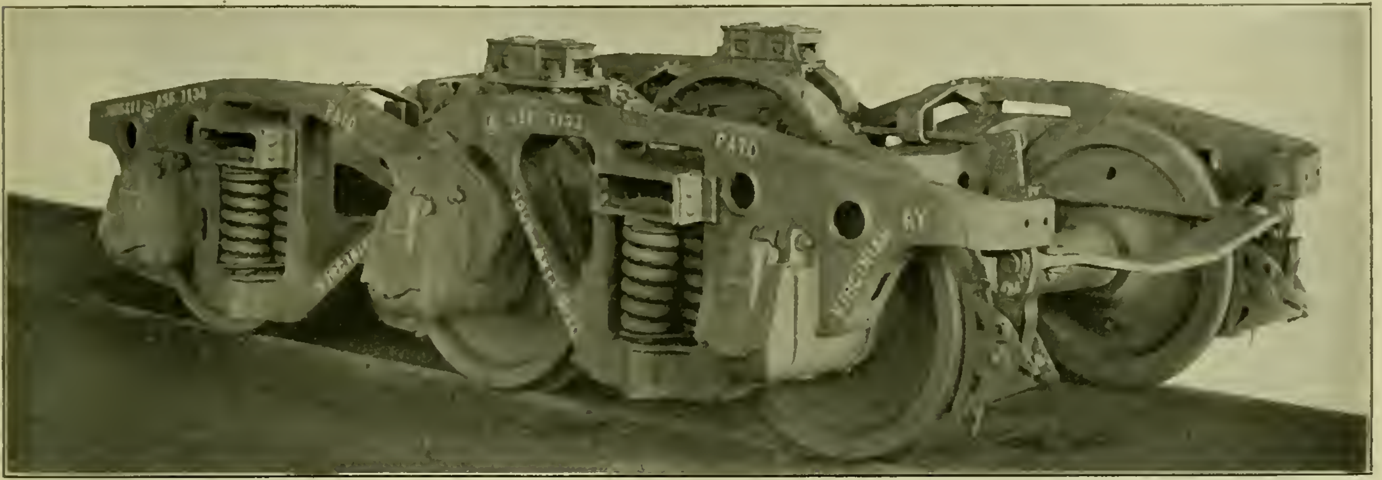
7,950 tons hauled with the smaller equipment. It is the opinion of the operating officials that with favorable weather conditions a train haul of 14,000 tons gross or 10,540 tons net load will be secured by the use of the 120-ton coal cars.

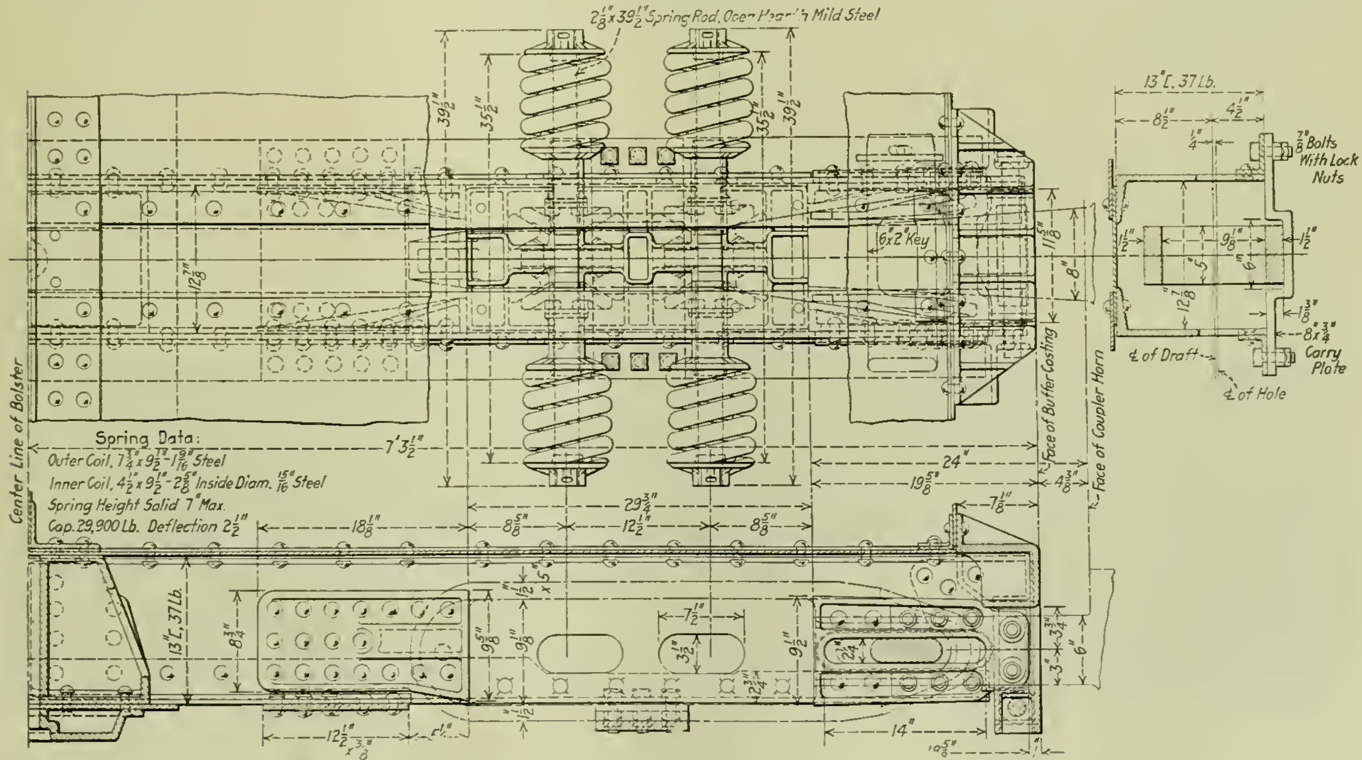
Construction of the Cars

As already mentioned, these cars have been made extremely wide and high in order to keep down the length.

The car body is 49 ft. 6 in. long by 10 ft. 2¾ in. wide inside and has a depth at the center of 8 ft. 5⅛ in. and at the ends over trucks of 7 ft. 4¼ in. The cubical capacity is 3,850 cu. ft. level full or 4,450 cu. ft. with a 30 degree heap. This latter figure, with coal at 54 lb. per cu. ft., is equivalent to approximately 240,000 lb. The cars are stencilled 218,000 lb. capacity, but, adding a 10 per cent overload, brings the capacity to approximately 240,000 lb., the load which the car is designed to carry, both from the standpoint of strength and as to dimensions.

The size of the car, coupled with the fact that it is deeper at the center than at the end, gives it the general appearance of one of the modern quadruple hopper cars. However, it is not a hopper car, as it has no hoppers, drop doors or means of discharge other than from the top. It is to be operated solely on the lines of the Virginian and dumped only in car-dumping machines. These facts suggested the design finally adopted.

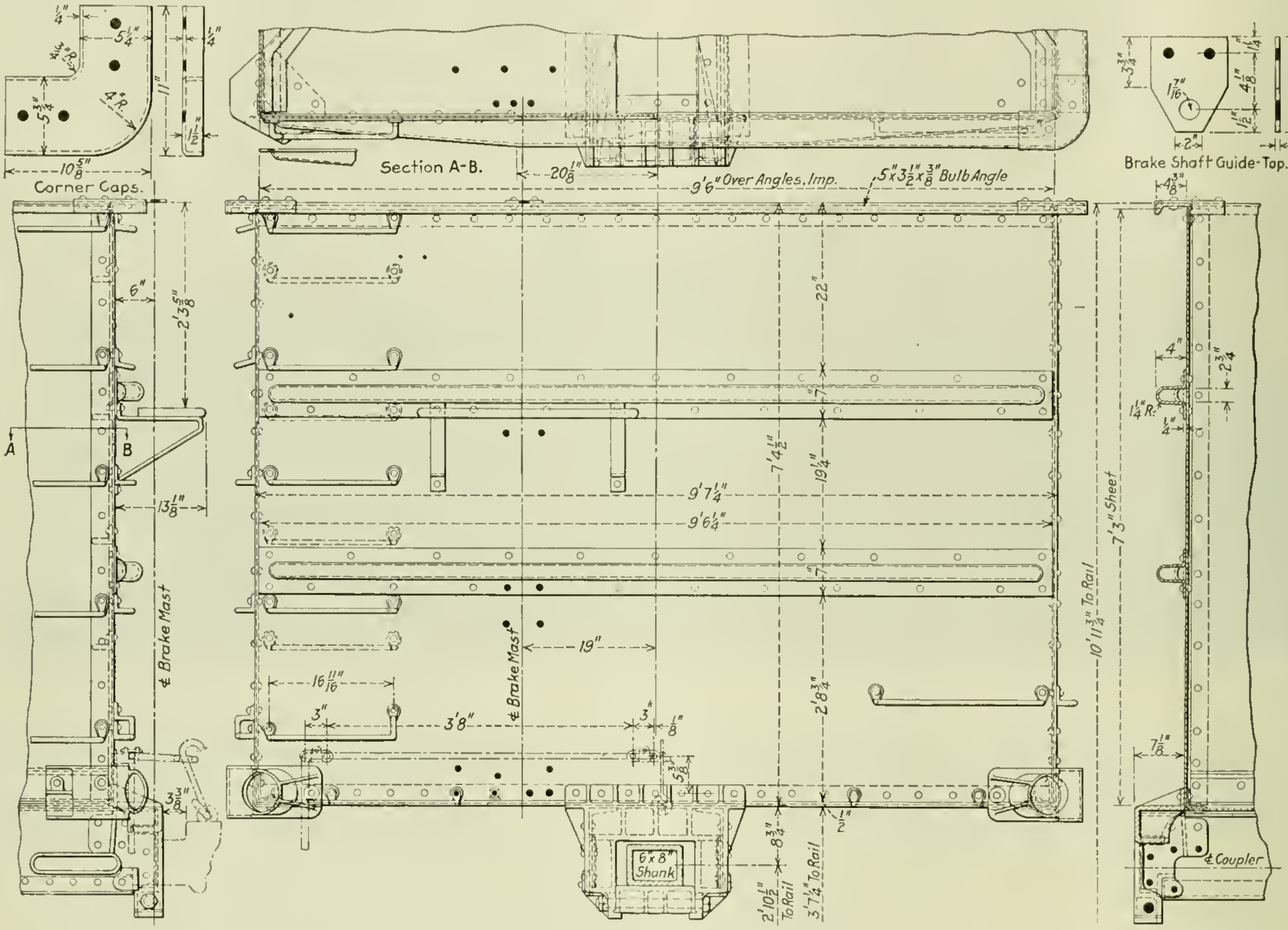

The Lewis Truck



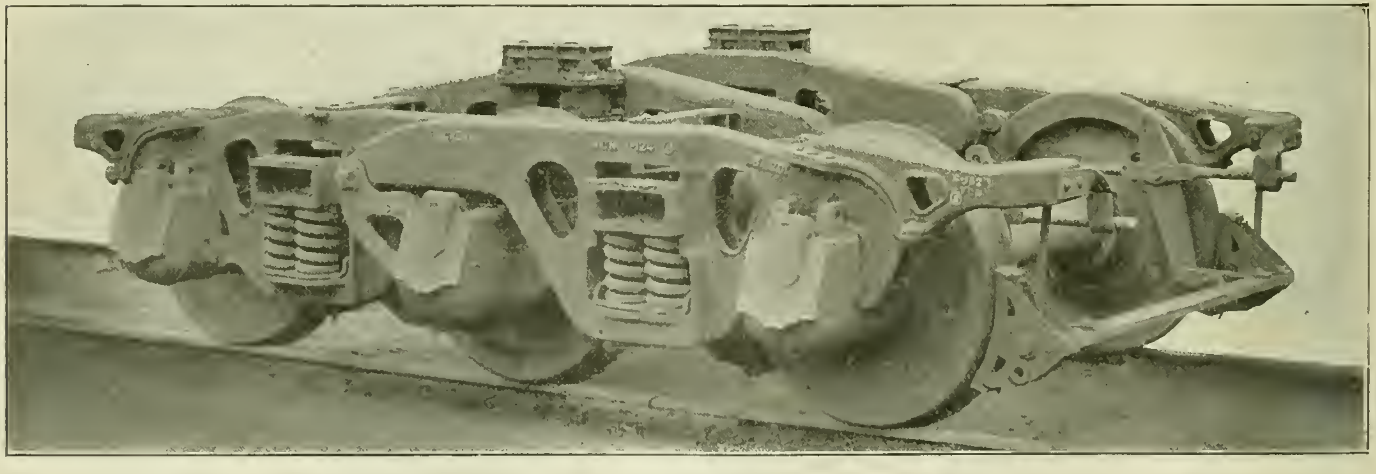
Arrangement of Cardwell Duplex Draft Gear

The sides, it will be noted, are entirely free from outside side stakes or other projections beyond the plane of the side sheets. The car presents a smooth, straight surface throughout the depth of the body at all points to engage the blocking and clamps in car dumpers, thus avoiding concentrated stresses on side stakes, top angles and other projections while the car is being dumped. This construction also admits of using practically all of the clearance width of the road for the inside or available loading width of the car and provides the required cubic capacity in a minimum length and height.

The sides are formed of ¼-in. plates sloped in near the top at an angle of approximately 15 degrees and then flanged out, overlapping the horizontal leg of the top angle to which they are riveted. The top angles are standard 4 in. by 4 in. by ½ in. rolled angles with the vertical flange outside in line with the plane of the side sheets. On the inside of the side construction 14 stakes are provided on each side and the connection between these stakes and the side top angle is effected through malleable iron castings, as is shown in the drawings of the car body. The side stakes consist of reinforced triangular gussets and 5-in. rolled bulb angles, all directly connected to bolsters, cross bearers and floor supports, all of which are located inside of the car body. Along the bottom the sides are reinforced by a 3½-in. by 3½-in. by ⅜-in. rolled angle, which also supports the floor. This angle extends to within approximately 2 ft. 4 in. from either end. At these points the plane of the side sheets is dropped back into the car to bring the ladders inside the clearance limits and also to afford these a certain amount of protection in car dumpers and elsewhere. The assembled side construction forms an efficient girder which will carry the entire weight of the lading as well as the dead weight of the car at a low fiber stress and leave the center sills to take care of the buffing stresses.

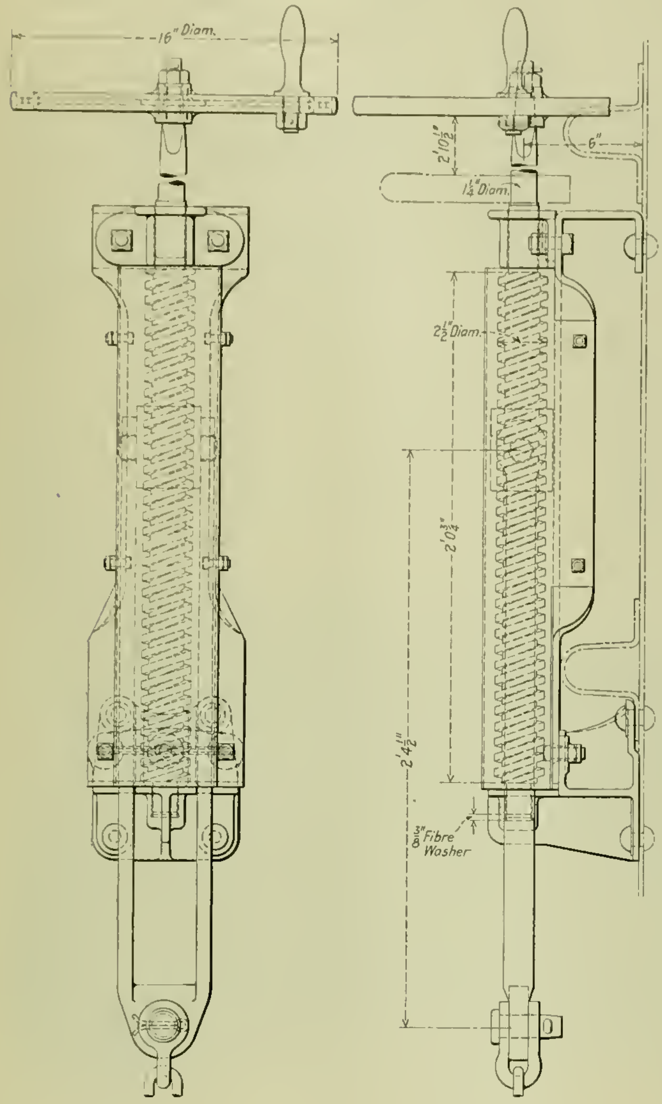


Details of the End of the Car Body



The Buckeye Six-Wheel Truck

The center sills are made up of two 13-in. 37-lb. standard rolled channels applied with the flanges toward each other and reinforced at the top by a cover plate and at the bottom by 4-in. by 3½-in. by ⅜-in. rolled angles. Five hundred cars are equipped with Westinghouse N-12-A draft gear and Lewis or Lamont trucks, being known as Class G-4 cars, while the remaining 500 cars have Cardwell duplex draft gear and Buckeye trucks. These are known as Class G-3 cars. On the Class G-4 cars the center sills are spaced 18½ in. apart and on the Class G-3 the standard 12⅞-in. spacing is employed. The center sills develop an effective buffing area of over 30 sq. in. and the ratio of stress to strain, figured according to A. R. A. practice, is below .05.



Details of the Screw Type Hand Brake

The ends are formed of ¼-in. plates reinforced at the top by a 5-in. by 3½-in. by ⅜-in. rolled bulb angle, intermediately by two pressed steel braces extending the full width of the car and at the bottom by the floor sheets, which are flanged up to engage the ends and are riveted thereto. The floor sheets are all ¼-in. plates and all floor supports, including bolsters and cross bearers, are of built-up construction.

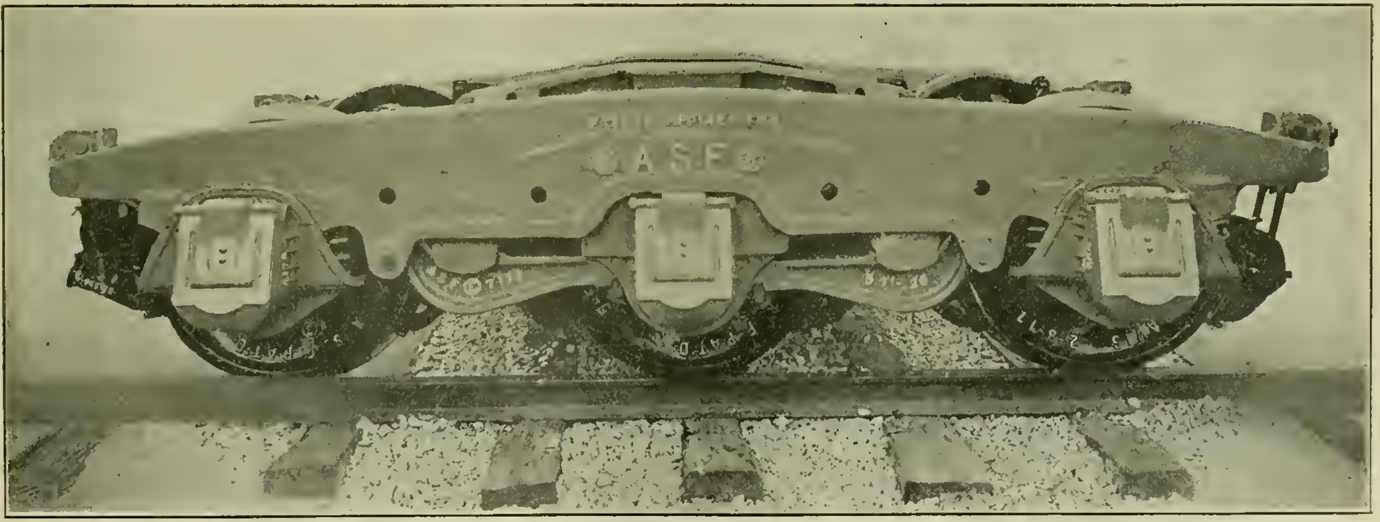
The trucks are of the six-wheel type with cast steel frames, two designs being used, as previously mentioned. They are equipped with A. R. A. standard 6-in. by 11-in. axles, 33-in. rolled steel wheels, Stucki side bearings and clasp brakes.

The Lamont Truck

The first application of the Lamont six-wheel truck, which has just been developed by the American Steel Foundries, has been made under ten of these cars. The outstanding features of this truck are its short wheel base of 8 ft. 3 in., the arrangement of the springs and equalizing system, and the three piece bolster which uniformly distributes the load over the four points of support.

The bolster is made up of a central or equalizing member and two cross bolsters. The central bolster carries the center plate and side bearings and at either end rests on the middle of one of the cross bolsters, the ends of which in turn are carried on the longitudinal equalizers under the side frames. The principal feature of the equalizing system is the location of the springs at the journal boxes instead of over the equalizer. The journal boxes are of special construction, in which seats are provided for coil springs on either side of each box, the truck frames resting directly on the springs of the end journal boxes. The springs at each of the middle journal boxes are spanned by a spring cap; on the middle of this cap bears an equalizer, from the ends of which are hung the inner ends of the main equalizers. The other ends of the latter are hung from the truck frames.

Westinghouse empty and load schedule KDE-4-10-16 brake equipment is used for the power brake and for braking the cars by hand, a special screw type of hand brake is provided, as the ordinary type would not be suitable for spotting these cars on dumpers and in handling them about the mines where, at points, it is necessary to drop them down steep grades after loading. The couplers are of a special design having A. R. A. type D heads and slots for connecting to



The First Application of the Lamont Truck Was Made on Ten of These Cars draft gear with 2-in. by 6-in. forged keys and cast steel yokes.

The completed cars are 10 ft. 11¾ in. high from rail to top of sides. The Class G-3 cars weigh 78,800 lb., of which 41,600 lb. represents the weight of the body and 37,200 lb. the weight of the Buckeye trucks. The Class G-4 cars weigh 78,900 lb., the body weighing 43,200 lb. and the Lewis trucks 35,700 lb. These dead weights make the ratio of revenue earning load to total weight hauled 75.3 per cent.

Tank Car Outlets and Other Projections

Colonel B. W. Dunn, Chief Inspector of the Bureau of Explosives, having received many letters protesting against the recent prohibition of nipples or other attachments to bottom outlet valves of tank cars, has issued a statement calling attention to the dangers incident to the transportation of gasoline.

The tank car committee of the American Railway Association finds the tank car and the locomotive tender, of all railroad equipment, the most liable to derailment; and in the case of the tank car, the breakage of the outlet chamber almost invariably follows the derailment and adds greatly to the danger of further damage.

The bottom outlets of tank cars have always given more trouble in connection with leakages and fires than any other cause. It is contrary to elementary principles of safety to make a hole in the bottom of a tank containing thousands of gallons of a dangerous inflammable liquid, and depend upon any device to keep it closed. On English railroads a bottom valve is not allowed in any "tank waggon" carrying inflammable liquids of the first class. Furthermore, such liquids as gasoline are not transported in "tank waggons" of any type.

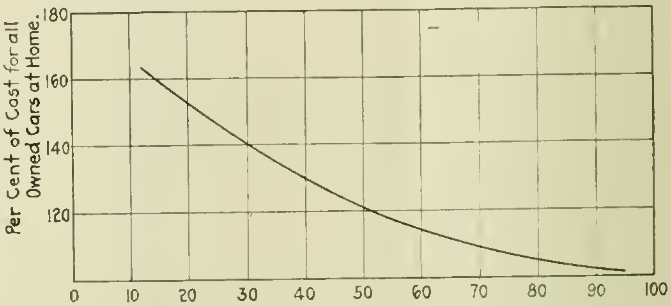
The Bureau of Explosives appreciates the difficulties. The desideratum is a car with valves which would not leak; but no valve has yet been placed in service which successfully accomplishes this result. The next best thing is to use a solid valve cap as a second defense against leakage at the bottom of the outlet chamber. If builders had made a serious effort years ago to make a really tight outlet, one might have been developed. It is hoped that some one of the experimental types now under service tests may prove satisfactory.

When extensions in the way of nipples and stop cocks are added to the outlet chamber the hazards are greatly increased. Valves extending below the bottom of the outlet chamber provide additional joints, each one of which is an additional possibility for leakage. These extensions are also liable to be struck and knocked off or ruptured by flying ballast or obstructions during transit. Consignees demanding these forget that the extensions increase the hazards while the car is moving. Gasoline is the most dangerous commodity transported on American railroads. The Bureau of Explosives' records show that from 1910 to the beginning of the present year, gasoline was responsible for 83 per cent of the deaths, 63 per cent of the personal injuries and over 49 per cent of the property damage occurring in the transportation of all classes of dangerous articles, exclusive of explosives. In the majority of the gasoline losses the bottom outlets started the trouble. So long as the railroads put up with this situation, just so long will improvement of the bottom outlet arrangement be delayed.

The action taken at the meeting of the tank car committee of the American Railway Association on June 4, 1920, against supplementary extensions, is believed to be a step in the right direction. It amended Section 7 of the Tank Car Specifications by adding sub-paragraph "c" providing that "No nipples, valves or other attachments, shall project below the bottom outlet cap except while car is being unloaded." This decision of the tank car committee was based principally upon the records of results in a large number of cases where this type of car was involved. The Bureau of Explosives heartily concurs in the action of the committee.

Effect on Cost of Repairs of Changes in the Percentage of Freight Cars at Home

In developing a method for arriving at allowances which should be made in the expenditures for maintenance of way and equipment in the application of test period amounts to guaranty period conditions in the settlement to be made between the railroads and the United States Government for the six months' guaranty period, following the return of the roads to private operation, a committee representing the railroads has made a study of the effect on the cost of maintenance of freight cars of variations in the proportions of home and foreign cars on the lines. The studies are based on information covering the test period received from 80 railroads owning 82 per cent of the freight car equipment of the country.



Change in Cost of Freight Car Repairs With Change In Per Cent of Cars at Home

The results of this study are shown graphically in the diagram, and the values from which the curves were plotted are given in the table. Starting with a cost of 100 per cent, or unity, for 100 per cent of owned cars at home, the cost increases at an accelerating rate as the per cent of owned cars on the home lines decreases. The cost shows an increase of 21.17 per cent when 50 per cent of owned cars are on home lines and with 25 per cent of the owned cars at home the cost of repairs is 45.56 per cent greater than the base figure. For 13 per cent owned cars at home, the smallest percentage covered by the actual observations, the cost of repairs is 61.21 per cent higher than the base figure, or over 33 per cent greater than when the normal proportion of half of the cars which the road owns are at home.

Effect on Cost of Repairs of Changes in Percentage of Freight Cars at Home

Change in Cost of Freight Train Car Repairs Due to Change in Percentage of Owned Cars on Home Line

Column 1—Average per cent owned freight train cars on home line of total owned freight train cars.

Column 2—Per cent of cost for all owned cars at home.

Col. 1	Col. 2	Col. 1	Col. 2	Col. 1	Col. 2	Col. 1	Col. 2	Col. 1	Col. 2
*1	179.32	21	150.55	41	128.94	61	113.61	81	104.39
*2	177.73	22	149.30	42	128.02	62	113.04	82	104.05
*3	176.15	23	148.06	43	127.09	63	112.48	83	103.70
*4	174.56	24	146.90	44	126.17	64	111.91	84	103.36
*5	172.97	25	145.56	45	125.24	65	111.34	85	103.02
*6	171.46	26	144.46	46	124.43	66	110.81	86	102.76
*7	169.95	27	143.36	47	123.61	67	110.28	87	102.49
*8	168.43	28	142.27	48	122.80	68	109.76	88	102.23
*9	166.92	29	141.17	49	121.98	69	109.22	89	101.96
*10	165.41	30	140.07	50	121.17	70	108.70	90	101.70
*11	164.01	31	139.01	51	120.41	71	108.26	91	101.51
*12	162.61	32	137.95	52	119.66	72	107.83	92	101.32
13	161.21	33	136.90	53	118.90	73	107.39	93	101.14
14	159.81	34	135.84	54	118.15	74	106.96	94	100.95
15	158.41	35	134.78	55	117.39	75	106.52	*95	100.76
16	157.09	36	133.80	56	116.75	76	106.16	*96	100.61
17	155.77	37	132.82	57	116.11	77	105.80	*97	100.46
18	154.44	38	131.83	58	115.46	78	105.45	*98	100.34
19	153.12	39	130.85	59	114.82	79	105.69	*99	100.15
20	151.80	40	129.87	60	114.18	80	104.73	*100	100.00

*Readings from curve projected beyond observations.

Container Car in Express Service on N. Y. C. Lines

American Railway Express Company Operates Experimental Car Between New York and Chicago

THE container system of transporting materials has been given much attention in the past and considerable progress has been made in development work. These experiments have, however, been made only in freight service in an attempt to relieve the congestion of traffic due to delays in loading or unloading the present type of freight car, particularly when handling less-carload shipments. Many of the same difficulties and delays are also encountered in handling express matter and this has led to the application of the container idea to the railway express service.

A container car designed especially for express service has been placed in operation on the New York Central between New York and Chicago. This car left New York recently in an American Railway Express train and after delivering its cargo of merchandise for leading Chicago department stores at the South Water street terminal of the Michigan Central Railroad, was reloaded and made a return trip to New York.

A Nine-Section Express Car

The car is a nine-section express car, its sectional cargo space consisting of nine separate containers or steel boxes firmly secured on the car to prevent shifting during train movement. Each container is removable so that it may be transported by motor truck between stores or factories and the railroad.

This new equipment was built by The Merchants Despatch Transportation Company of East Rochester, N. Y. It consists of a modified low-side gondola car carrying nine containers which may be lifted on or off the car by means of a crane or other type of hoisting apparatus. The car is constructed along the lines of the New York Central standard 60 ft. baggage car and is mounted on two four-wheel trucks of the passenger type. It is equipped with passenger buffers and with air, steam, and signal line connections so that it may be operated in passenger train service. The underframe is of steel construction throughout having a deep center sill which is supplemented by the construction of the car sides. The superstructure consists of a low steel side framing—about 30 in. high—having side plates of steel which stiffen the car frame and also serve to prevent any sidewise movement of the containers. The sides are connected at each end of the car to a cast steel anti-telescoping end-frame which is approximately the same height and width as a passenger car, having much the same appearance as a blind-end baggage car.

The containers are designed so that they may readily be removed from the car and loaded upon automobile trucks. They are 9 ft. long by 6 ft. wide inside, have an inside clear height of 7 ft. 4 in. and a capacity of 6,000 lb. They are substantially built of structural steel and being entirely of metal will eliminate the losses due to damage from fire. A door is provided in one side of each container through which the material is loaded and the door then locked and sealed. The container is then placed upon the car where the side of the car which projects above the base of the door gives additional security to the contents as the door cannot be opened until the container is raised above the top of the side frame. This feature makes the pilfering of goods—now so prevalent—practically impossible. Besides the facility with which the container and its contents may be handled, this method of transportation is expected to eliminate much of the delay caused by the detailed billing and re-checking of small shipments.

On the initial trip of this express car, the handling of the loaded containers was accomplished with surprising speed. With no special station equipment—only a locomotive crane being available—the containers were transferred from motor trucks to their positions on the car in from 30 seconds to two minutes each. Under existing conditions, this nine-section express car could therefore be unloaded and reloaded ready to proceed within 40 minutes. No crew of handlers equipped with trucks could possibly equal this performance.

In addition to the nine-section steel container car now in passenger train express service, there are at the present time

New York Central Container Car Designed for Handling Express Matter, Equipped with Passenger Trucks and Buffers and with Air, Steam and Signal Line for Passenger Train Operation under construction at the plant of the Merchants Despatch Transportation Company other container cars for use in freight train service. These cars, which are 46 ft. long, are provided with steel underframe, wooden sills and floors, and steel sides and ends about 24 inches high for holding the containers in place. The cars will be equipped with standard freight car trucks and will be in every way suited for regular freight train service. The containers now under construction for use with these cars in freight service are 15 ft. long, and three containers will be used on each car. They are constructed with steel sides, ends, roofs and floor frames, wooden floors and sheathing and doors in one end only.

Other Container Cars Under Construction

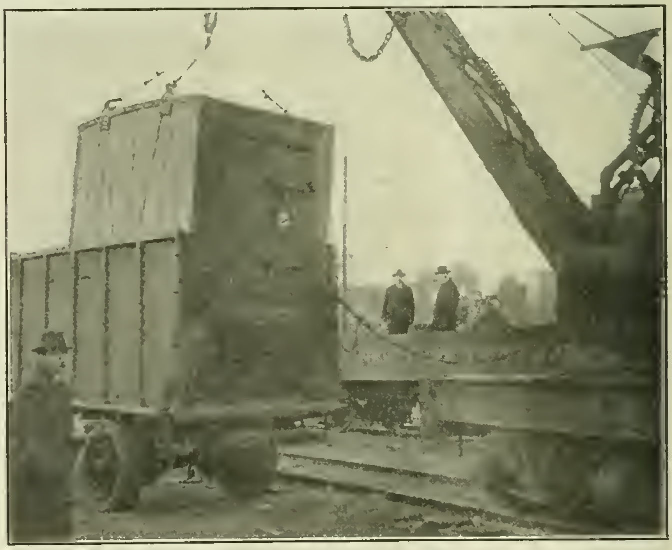
It is expected that this container car system will be expanded by the New York Central to completely co-ordinate the steam railroad, the motor truck and the electric railway. If it proves to be successful in actual service it will bring about a new system of handling less-carload freight and express matter between large centers of population. The New York Central primarily seeks greater security for shipments in transit, the losses to the railroads through the theft and damage of goods having increased alarmingly in recent years—the aggregate annual loss and damage claims paid by American railroads in 1920 having been increased about 300 per cent since 1914. Several other points of improvement in service are expected from the container car system of transportation. This system provides that the portable containers shall be loaded and locked on the shippers' premises and then conveyed by motor truck and lifted aboard the car. At destination the locked container is carried by motor truck direct to the consignee. All of the intermediate handling and checking processes are done away with.

Empty Container Showing Interior and Door Construction

Another advantage of the new system which is expected to prove most valuable is greatly increased use of rolling stock in actual service. This is particularly important when traffic expands to its "peak" and the prime need is to shorten lay-overs of cars in yards and stations for loading and unloading, and to limit their idleness through misuse for storage purposes. With ample supplies of the removable containers, which in their several classes will be of uniform size and interchangeable, one carload of the containers may be removed and sent with their loads to consignees, and another set immediately hoisted to their places and the car be ready to proceed within a matter of minutes. The containers may remain on station platforms or on the premises of shippers for loading or unloading at convenience, without tying up rolling stock at points where track capacity is limited.

Locomotive Crane Placing a Loaded Container on the Car

One of the difficulties that will be encountered in the operation of this system will be the lack of adequate lifting apparatus on the premises of many shippers, which will necessitate the tie-up of a motor truck while the container is unloaded and reloaded. Other difficulties that must be overcome are: the possibility of scattering the containers over too wide a territory and the probable lack of sufficient suitable traffic in one direction. These objections to such a system are, however, vastly outweighed by the advantages.



A Loaded Container Being Lifted From the Motor Truck

The performance of this first car in express service will be followed closely and it is expected that in a future issue, the readers of the *Railway Mechanical Engineer* will be given some very interesting operating data.

Draft Gear Tests of the Railroad Administration

First of a Series of Articles Describing Investigations Conducted by the Inspection and Test Section

THE draft gear tests of the United States Railroad Administration were originally undertaken at the request of the Committee on Standards for Locomotives and Cars and the Central Advisory Purchasing Committee for the purpose of determining the relative merits of the several commercial gears in order that mechanical excellence and costs might be evaluated. The Inspection and Test Section, as a preliminary to any work, carefully studied all of the common methods of testing draft gears. Letters on the general subject were also addressed by the section to all of the draft gear manufacturers and to a large number of prominent mechanical officers of the roads, the replies to which showed a wide difference of opinion, not only as to the proper method of testing draft gears, but as to what performance should be expected from a gear.

A comparison of the many test reports submitted showed an entire inconsistency in results, supposedly obtained under similar conditions. It became evident that a test of all gears under exactly the same conditions, removed from any proprietary influence, was essential, and also that the tests should be conducted in such a manner as not only to determine the comparative value of the several gears, but to obtain all the exact information possible with respect to draft gear action, and to extend the study as far as possible toward the ultimate determination of the ideal draft gear. With such a program in view, the co-operation of the A. R. A. Committee on Draft Gears was felt to be desirable, and upon invitation from this section, this committee has taken an active part in the test work and in analyzing and compiling the results.

The present report covers in a rather extensive manner the action and comparative merits of the various gears when considered from the viewpoint of impact and buffing. The opportunity for the investigation of draft gears in train starting and similar operations has not developed as was hoped for, so that it is impossible at this time to present definite information in this latter respect.

The full investigation of draft gears should include not only the laboratory and impact tests of the present report, but also a wide range of train operation tests and service tests, from the results of which should be determined:

1. The minimum amount of movement necessary between cars for starting trains, and whether this movement may be free slack, as between coupler knuckles, or whether it should be resisted movement.
2. Whether the beginning of draft gear compression should be an easy movement or a stiff movement, and whether there should be an initial compression to prevent movement from slight shocks.
3. The effects of recoil and what amount of release force is desirable.
4. The desired capacity, travel and ultimate resistance of the gear, as well as the shape of the curve representing draft gear resistance for both buffing and train starting.
5. The coupler horn and coupler shank clearance.
6. The life, together with the rate of wear and loss in gear capacity attending it, that should be expected from an acceptable draft gear, as well as the setting of a measure, either in time, mileage, or loss of capacity, when a draft gear should be removed from the car and be repaired or scrapped.

Draft Gear Testing

The following discussion on the general subject of draft gear testing is given for the benefit of any who may be called upon to do similar work in the future.

It is important to have a full knowledge of the condition of each test gear before putting it into a test. Check measurements should be made, such as spring heights, barrel or housing dimensions, initial spring compression, initial friction compression, absolute free height, absolute friction height, and solid height, keeping a record of possible travel at any of the previously mentioned gear heights. By having such a record it will later be possible to check up the gear conditions and to know whether any loss in travel is due to set of springs, wear of friction members or deformation of parts of the gear. Depreciation in any of these respects should be reported in equivalent loss in coupler or gear travel.

It is important to protect the friction surfaces of test gears from any grease, rust or moisture. Even the handling of the friction faces with bare hands may leave enough grease or moisture on them to lower the gear capacity.

In testing draft gears, the gear should not be loaded beyond the solid point. Few gears will stand much service beyond their normal capacities, especially under the drop machine. The determination of the solid point, however, is often quite difficult. The static test is best suited to accurately fix the limit of normal gear closure. In tests of other characters, such as the drop test, the gear should be closed only to the travel determined from the static cards as the limit of normal gear action.

All gears, irrespective of construction, should be set up and restrained in a suitable testing frame, corresponding in dimensions to the draft gear pocket in the car. The frame should be so designed that the influence of its yield will be minimized. The gear should rest in the frame upon pieces of metal corresponding to the stop faces of the gear draft lugs or other stop member. A striking plate of the same size as the coupler butt should be placed on top of the gear for receiving the blow. This will develop whether or not the gear construction is substantial enough to receive the coupler butt forces in service. Where followers are regularly used with a gear, they should, for comparative purposes, be set up with the gear in the testing frame. In all respects service conditions should be simulated in the testing frame, as in no other manner will the weak or strong points of a gear be shown. It is more convenient to test gears such as the Miner, Westinghouse and similar types without a frame, but a frame is necessary for some other gears, such as the Cardwell, and in any impact testing the yield of the frame, no matter how carefully constructed, may slightly increase the results. It is therefore only fair that all gears should be tested under similar conditions.

It is a noticeable fact, however, that if a friction gear is brought for testing from a cold place into a warm room, the capacity will be low; and if brought from a warm room to a colder outside atmosphere, the capacity will be higher. This is due to the deposit of moisture on the colder metal, or the abstraction of moisture from the friction surfaces of the warmer metal, as the case may be. In general the humidity of the air is a decided factor in testing, and an instance is known of a depreciation of 20 per cent in a gear which could be explained in no other manner.

Another point of interest is that when a gear is to be given a static test without a frame, and the free height of the gear is greater as set up than the pocket length in the car, the gear should first be compressed to slightly below the pocket dimension and then released to the exact pocket length. The compression test should then start from this released point.

In impact testing, where the load passing through the gear to the supporting device is measured or compared, the gear should never be tested beyond the closing point. This rule applies particularly to rivet shearing tests and car-impact tests. It should be remembered that after a gear goes solid its normal functioning ceases, and further testing is only of the gear housings or barrel. Hence in over-solid testing the greater deformation of a weaker gear barrel offers additional protection to the rivets for the time being, and also offers more yield in the car tests. Any considerable repetition of such over-solid blows would, however, shortly destroy the gear. On the other hand, a sturdy gear will usually shear the rivets at the first over-solid blow and will similarly produce a sudden change in car velocity, but the sturdy gear will not be so quickly destroyed. For a full knowledge of the functioning of a gear it is necessary to know only its capacity up to the point of closure and the character of its action within that capacity. Any yield or cushioning beyond the solid point is due to deformation or spring of the heads or barrel, and is obtained only at the expense of strength and life of the gear.

The suggestion is frequently made that all gears be tested to determine the point where a force of say 500,000 lb. is set up in the sills. On the face this would appear to be entirely reasonable and a proper test for the grading of gears. But for the same reasons as before, a premium would be placed upon a weak gear construction. Furthermore, it is a fundamental principle of mechanics that there can be no force set up in any structure greater than the resistance offered by the structure. It therefore follows that if a gear were constructed with an ultimate strength value of 400,000 lb. it would be physically impossible to apply 500,000 lb. through it to the car. Hence, the only over-solid draft gear tests that should be made are those that will discover the weakness of a gear rather than credit it with false merit. The destruction and endurance tests are the only over-solid draft gear tests known that will correctly rate the gears in this respect.

Another practice from which wrong conclusions are often drawn is that of testing gears against sills of different sizes and conditions. It is not fair to set up one gear on heavy channels and another on light channels, as again, the force developed will depend upon the yield and the resistance offered by the channels. Thus if a test were made upon 20-lb. channels it would be unreasonable to expect as high a force as upon 30 lb. or 40 lb. channels, for not only is there a greater yield of the channel, but the elastic limit of the material in the lighter channels might be reached and passed, which would preclude the possibility of reaching as high a force as might be shown in the heavier channels. In other words, it is impossible to put more load into the light channels than they will stand, as the force is limited by the resistance of the structure supporting the gear.

Test Program

The following general program was decided upon for the present tests as offering the best means of investigating the comparative action of the gears:

9,000 lb. Drop Tests—Solid Anvil.
  Closing gears by drops of 1 in. increments.
  Recoil tests.
  Investigation of influence of foreign material on friction surfaces.
  Investigation of rivet shearing tests.
  Destructive tests.
Static Tests.
  Closing gears at a rate of 1/8 in. per minute.
  Closing gears at a rate of 3/4 in. per minute.
  Closing gears at a rate of 3 in. per minute.
Car Impact Tests.
  Calibrated gear in one car only, solid buffer in another car.
  Calibrated gears in both cars.

In general three each of 18 different types of draft gears are embraced in the tests. The table of Fig. 1 has been prepared to identify the gears and to give other data of prime interest in connection with them. Fifty-nine gears in all were used because of gear failures developing during the progress of the various tests.

Description of Gears

In the report as presented, the gears used are described at some length. Since practically all of the types tested are in common use, these details will be omitted and the description will be confined principally to those features which differ from the usual practice.

Westinghouse Type D-3.—This is the well-known friction draft gear of the Westinghouse Air Brake Company. It has a nominal travel in the car of 2 7/16 in., the first 5/8 in. of which is spring travel, the remainder being friction travel.

TEST GEAR NUMBER	MAKE AND TYPE OF GEAR	NOMINAL TRAVEL	NOMINAL LENGTH	AVERAGE WEIGHT ONE GEAR	NUMBER OF STD. FOLLOWERS REQ'D PER CAR	COMPARATIVE WEIGHT PER CAR
	①	②	③	④	⑤	⑥
1 2 3	WESTINGHOUSE D-3	2 7/16"	20 1/8"	200#	4	684#
4 5 6 7 8	WESTINGHOUSE NA-1	3"	22 1/8"	368#	2	878#
9 10 11 12	SESSIONS K	2 1/16"	20 1/8"	252#	4	788#
13 14 15	SESSIONS JUMBO	3"	24 5/8"	433#	0	866#
16 17 18	CARDWELL G-25-A	2 3/4"	24 5/8"	440#	0	880#
19 20 21	CARDWELL G-18-A	3 3/16"	24 5/8"	440#	0	880#
22 23 24	MINER A-18-S	2 1/2"	22 3/8"	346#	2	834#
25 26 27	MINER A-2-S	2 1/2"	20 1/8"	207#	4	698#
28 29 30	NATIONAL H-1	2 1/2"	24 5/8"	428#	0	856#
31 32 33	NATIONAL M-1	2 1/2"	24 5/8"	372#	0	744#
34 35 36	NATIONAL M-4	2 1/2"	24 5/8"	322#	0	644#
37 38 39	MURRAY H-25	2 3/4"	24 5/8"	376#	0	752#
40 41 42	GOULD 175	2 1/2"	22 3/8"	337#	2	816#
43 44 45 46 47	BRADFORD K	2 1/2"	24 5/8"	386#	0	772#
48 49 50	WAUGH PLATE	2 1/4"	24 5/8"	420#	0	960#
51 52 53	CHRISTY	2 1/2"	22 3/8"	442#	2	1026#
54 55 56	HARVEY 2-8"x8" SPGS.	1 7/8"	7 7/8"	104#	8-1 1/2" Followers	670#
57 58 59	COIL SPRINGS 2-8x8-CLASS G	1 7/8"	7 7/8"	110#	8-1 1/2" Followers	682#

Fig. 1—Gears Included in the Test Program

Westinghouse Type NA-1:—This is a new gear recently introduced by the Westinghouse Air Brake Company. A description of its construction will be found in the Railway Age, Daily Edition for June 14, 1920, page 1785. The nominal travel of the gear in service is 3 in.

Sessions Type K:—This is the type of gear manufactured by the Standard Coupler Company and used on 50,000 of the United States Railroad Administration cars. The gear has a nominal travel of 2 1/16 in., the first 1/8 in. of which is spring travel and the remainder friction travel.

Sessions Jumbo:—This is a heavier gear of 3 in. nominal travel recently developed by the Standard Coupler Company and is similar to the Type K gear.

Cardwell Type G-25-A:—This is the regular pattern of the Union Draft Gear Company's gear slightly modified to give a nominal travel of 2¾ in.

Cardwell Type G-18-A:—This is the regular Cardwell gear of the Union Draft Gear Company with 3 3/16 in. nominal travel.

Miner Type A-18-S:—This is a slightly modified arrangement of the well-known A-18 gear of W. H. Miner and is the design applied to United States Railroad Administration locomotive tenders. The gear has a nominal travel of 2½ in.

Miner Type A-2-S:—This is a slightly modified arrangement of the A-2 gear of W. H. Miner, the nominal travel being 2½ in.

National Type H-1:—This is a new gear of 2½ in. nominal travel, manufactured by the National Malleable Castings Company. A central friction column with four ways in it is cast integral with one follower of the gear. In these ways are four friction segments, or shoes. The other, or movable follower, is arranged to wedge these shoes inwardly into the ways of the column and, as the gear is closed, the longitudinal movement of the shoes is resisted by a single coil friction spring that surrounds the friction column below the wedges. Four independent corner posts of 1⅝ in. diameter steel are provided to receive the blow when the gear goes solid, so that this force is received on entirely different metal. An independent release spring surrounds each of these corner posts. The gear is held to any desired length and as a self-contained unit by means of two ¾ in. rods.

The friction members of this gear are made of electric steel, hardened. The corner posts are of tempered knuckle-pin steel.

National Type M-1:—This gear is similar in construction to the National Type H-1, the most notable difference being that but two release springs are used instead of four as in the H-1 gear. Otherwise the same description serves for both. The nominal gear travel is 2½ in.

National Type M-4:—This gear is of the same general construction as the two preceding National gears, but has three flutes in the center column with three friction shoes, and has no independent release spring. Otherwise, the design is the same as for the other National gears. The nominal travel is 2½ in.

Murray Type H-25:—This gear is of the regular Murray pattern without wear blocks as manufactured by the Keyoke Railway Equipment Company, but was specially designed to give a nominal travel of 2¾ in. for use on Railroad Administration cars.

Gould Type 175:—This is the original Gould friction draft gear, manufactured by the Gould Coupler Company. It has single angle friction wedges pressed outwardly against the friction faces of the barrel by two sets of half-elliptic springs. It has a nominal travel of 2½ in.

Bradford Type K:—This gear is of the rocker type and is manufactured by the Bradford Draft Gear Company. The nominal travel is 2½ in.

Waugh Plate Type:—This is the well-known plate gear of the Waugh Draft Gear Company. As included in the test, each gear was made up of four sets of plates in series, each set consisting of 15 steel plates, ¼ in. by 6 in. by 11⅞ in. The nominal travel is 2¼ in.

Christy Gear:—This gear, when tested, was under development by the American Car Roof Company. It has since been taken over by the Standard Forgings Company and, in a modified form, is now known as the Stanforge friction draft gear. A description of the gear in its present form can be found in the Railway Age, Daily Edition for June 14, 1920, page 1784. The nominal travel is 2½ in.

Harvey Friction Springs:—These are the regular interwound Harvey friction springs as manufactured by the Frost Railway Supply Company. Each gear, as included in the test, consisted of two of these springs set in twin fashion, side by side. The nominal travel was 1⅞ in.

A. R. A. Class G. Springs:—These are the regular A. R. A. draft springs of 8 in. diameter and 7⅞ in. high.

Selection and Condition of Test Gears

At the beginning of these tests the various manufacturers were asked to furnish gears for test purposes, so that the gears as tested were in each instance procured directly from the proprietor, with full knowledge on his part that they were for test purposes. Whether or not gears of average manufacture were furnished must be decided from previous or additional experience with the several gears and from a knowledge of the manufacturing practices of the concerns. Unless a definite statement to the contrary appears in this report it is to be understood that gear conditions and performances as developed during the tests are in accordance with what is believed to be average conditions.

Immediately upon receipt of a test gear it was given a test number and then taken apart. The parts were marked, and measured for comparison with the manufacturer's drawings and for later comparative tests measurements. The gears were reassembled with the parts in their original positions and were given a definite amount of preliminary drop test work to condition them for the regular tests.

Westinghouse D-3:—These gears as received were in good average condition and conformed very closely to the dimensions given on the manufacturer's drawings. The results obtained in the test agreed very well with the results obtained in other tests of the same gear.

Westinghouse NA-1:—The gears as received appeared to be in average condition and the results of the test in general are believed to be representative of the action of the average product.

Sessions K:—The gears as received represented average workmanship and condition and the results of the test in general are comparable with previous tests of the same gear.

Sessions Jumbo:—These gears as received represented average workmanship and condition. The results of the test are believed to be representative of the commercial gear.

Cardwell G-25-A:—These gears as received were in average condition as to workmanship. The springs furnished for the test gears were of excessive length, the average free length being 10 1/16 in., whereas the drawing dimension is 9½ in. With all the parts properly assembled on the spring rod, the springs from the drawings should be under 3/16 in. compression, while with the gears as furnished, the springs were under ⅝ in. compression. The average drop test results obtained from these gears are greater by slightly more than 4 in., than the average results obtained in routine acceptance tests of the same gear. The lowest capacity gear of this type in the present test is more than 3 in. greater than the highest capacity gear of the same type in the Railroad Administration's acceptance test. It is, therefore, believed that the results obtained from these test gears are not representative of what may be expected from the regular product as furnished commercially.

Cardwell G-18-A:—These gears were received in average condition as to workmanship and the parts conformed more closely to the drawings than in the case of the G-25-A, although they averaged above the drawings. The individual variations, however, would probably be accepted as within manufacturing limits. The averages are believed to more nearly represent the true value of the commercial gear than those obtained from the other Cardwell type.

Miner A-18-S:—These gears as received were in good average condition as to workmanship and material. The results obtained are in harmony with those of other tests and the gears are believed to be representative of the commercial product.

Miner A-2-S:—The condition of these gears as received correspond with that of the Miner A-18-S and the test gears are believed to be representative of the commercial gear.

National H-1:—These gears conform closely to the drawing dimensions. The results obtained are comparable with results obtained in other tests of this gear and are believed to be representative of the gears as furnished commercially.

National M-1 and M-4:—The condition of these gears corresponded with that of the other National gears and is believed to be representative of the commercial product.

Murray H-25:—These gears as received had probably been given more conditioning than any other gears in the test, yet the results are not believed to have been influenced especially as they are just slightly below the average routine acceptance test of the same type for Railroad Administration cars.

Gould 175:—These gears conformed with drawings and appeared in good average condition except for a coating of grease which was found in the interior. The manufacturer disclaimed all knowledge of this and the parts were cleaned and the gears placed in a satisfactory condition. The results of the test are believed to be representative of the action of the commercial product.

Bradford K:—The undeveloped state of this gear makes it impossible to compare the test gear with the commercial product. It is felt that avoidable defects in workmanship and design are responsible, at least in part, for the breakage of gear parts noted later in the report.

Christy Gear:—As this gear was undeveloped and had never been furnished commercially, comparisons are impossible. The test gears had all of the friction surfaces machined, although it is understood that the gears were designed to be furnished regularly of rough castings. Some of the parts did not correspond to the dimensions on the drawings and the gear travel was ⅜ in. less than the drawings called for.

Harvey Friction Springs:—The spring group constituting these gears conforms reasonably closely to the drawing dimensions and the results of the test are believed to be representative of the commercial product.

A. R. A. Class G Springs:—The springs used in this test were of ordinary carbon steel oil tempered, drawn from regular railroad stock conforming to A. R. A. specifications.

DRAFT GEAR TESTS OF THE RAILROAD ADMINISTRATION

			Actual results from test gears						Average results to be expected from commercial gears 9,000 lb. weight				
				9,000 lb. weight									
Make and type of gear	Nominal travel, in.	Test gear number	Travel obtained, in.	Free fall to close gear, in.	Total fall to close gear, in.	Recoil above closing point, in.	Work done, ft. lb.	Work absorbed, ft. lb.	Total fall to close gear, in.	Recoil above closing point, in.	Work done, ft. lb.	Work absorbed, ft. lb.	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Westinghouse D-3	2 7/16	1	2.50	16	18.50	3.70	13,875	11,100	19.8	3.8	14,850	12,000	
		2	2.50	17	19.50	3.75	14,625	11,813					
		3	2.50	19	21.50	3.83	16,125	13,253					
Westinghouse NA-1	3	4	3.00	25	28.00	....	21,000	......	26.0	3.4	18,750	16,200	
		5	3.00	27	30.00	....	22,500	......					
		6	3.06	24	27.06	3.52	20,295	17,655					
		7	3.00	23	26.00	3.50	19,500	16,875					
		8	3.00	22	25.00	3.27	15,000	12,548					
Sessions K	2⅛	9	2.00	19	21.00	....	15,750	......	18.8	4.3	14,100	10,875	
		10	2.17	16	18.17	3.78	13,628	10.793					
		11	2.06	18	20.06	4.43	15,045	11,723					
		12	2.06	16	18.06	3.92	13,545	10,605					
Sessions Jumbo	3	13	3.10	23	26.10	5.03	19,575	15,803	28.1	5.2	21,075	17,175	
		14	3.06	24	27.06	5.06	20,295	16,500					
		15	3.00	28	31.00	6.44	23,250	18,420					
Cardwell G-25-A	2¾	16	2.75	19	21.75	3.61	16,313	13,605	*18.9	2.8	14,175	12,075	*See text.
		17	2.75	18	20.75	2.92	15,563	13,373					
		18	2.75	18	20.75	3.12	15,563	13,223					
Cardwell G-18-A	3 3/16	19	3.25	19	20.25	1.82	15,188	13,823	19.6	1.5	14,800	13,575	
		20	3.29	15	18.29	1.00	13,718	12,968					
		21	3.25	17	20.25	1.54	15,188	14,033					
Miner A-18-S	2½	22	2.51	15	17.51	4.18	13,133	9,998	19.9	4.6	14,925	11,475	
		23	2.52	17	19.52	4.53	14,640	11,243					
		24	2.53	20	22.53	4.87	16,898	13,245					
Miner A-2-S	2½	25	2.55	11	13.55	3.83	10,163	7,290	13.2	3.8	9,900	7,050	
		26	2.53	11	13.53	3.82	10,148	7,283					
		27	2.50	10	12.50	3.79	9,375	6.533					
National H-1	2½	28	2.53	29	31.53	4.61	23,648	20,190	31.2	4.6	23,400	19,950	
		29	2.50	30	32.50	4.80	24,375	20,775					
		30	2.50	27	29.50	3.97	22,125	19,148					
National M-1	2½	31	2.52	16	18.52	3.14	13,890	11,535	19.2	3.4	14,400	11,850	
		32	2.53	16	18.53	3.22	13,898	11,483					
		33	2.53	18	20.53	3.61	15,398	12,690					
National M-4	2½	34	2.54	17	19.54	2.13	14,655	13,058	21.5	2.4	16.125	14,325	
		35	2.46	21	23.46	4.44	17,595	14,265					
		36	2.53	19	21.53	2.32	16,148	14,408					
Murray H-25	2¾	37	2.65	15	17.65	3.68	13,238	10,478	17.0	3.3	12,750	10,275	
		38	2.47	14	16.47	3.41	12,323	9,795					
		39	2.81	14	16.81	3.20	12,608	10,208					
Gould 175	2½	40	2.38	16	18.38	7.68	13,785	8,025	18.1	7.1	13,575	8,250	*Gould gear No. 41 was 1/16 in. shorter than the pocket length.
		41	*2.44	15	17.44	6.94	13,080	7,875					
		42	2.50	16	18.50	7.29	13,875	8,408					
Bradford K	2½	43	2.38	Failed	.....	....	......	......	10.8	5.3	8,100	4,125	
		44	2.44	Failed	.....	....	......	......					
		45	2.45	9	11.45	5.41	8,588	4,530					
		46	2.44	6	8.44	5.19	6,330	2,438					
		47	2.44	10	12.44	5.87	9,330	6,242					
Waugh Plate	2¼	48	2.17	12	14.17	8.04	10,628	4,598	13.9	7.6	10,425	4,725	
		49	2.25	11	13.25	7.25	9,938	4,500					
		50	2.25	12	14.25	8.22	10,688	4,523					
Christy	2½	51*	2.32	12	14.32	3.38	10,740	8,228	19.6	5.1	14,700	10,875	*Christy gear No. 51 was .22 in. shorter than the pocket length. Gear No. 52 was .38 in. shorter than the pocket length and Gear No. 53 was 3/16 in. shorter than the pocket length.
		52*	2.21	16	18.21	4.96	13,658	9,938					
		53	2.28	24	26.28	5.87	19.710	15,308					
Harvey 2-8 by 8 in. springs	1⅞	54	1.88	6	7.88	3.84	5,910	3,130	9.5	4.2	7,025	3,975	
		55	1.76	9	10.76	4.51	8,070	4,688					
		56	1.83	8	9.83	4.22	7,373	4,208					
Coil springs 2-8 by 8 in., Class G	1⅞	57	1.83	4	5.83	4.16	4,373	1,253	5.8	4.1	4,350	1,275	
		58	1.70	4	5.70	4.08	4,275	1.215					
		59	1.71	4	5.71	4.11	4,283	1,200					

Table 1—Comparative Performance of Gears in Shop Tests

Application of Limit Gages and Progressive Sizes in Railway Machine Shops*

BY COL. H. E. O'BRIEN

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The adoption of graduated sizes of pins and holes and the bushing of holes subject to wear are two valuable methods of effecting economies.

The parts to be handled in the machine shop usually associated with "General Repairs" are—motion, valves and cab details.

The Foreman and His Training

The foreman directs the efforts of a group of workers.

He is ordinarily selected from the ranks because of his reputation as a master workman; in that capacity, however, he has had little, if any, training or experience in managing other workers.

Obviously the prime responsibility of a foreman is to understand human nature and direct human beings—a very different sort of task from handling tools or operating machines.

What sort of training should a foreman receive before he enters upon his new task? Who will be responsible if he fails to make good? What do you think about it?

Motion

The motion is dismantled in the erecting shop, examined, and results of examination posted on to the machine shop, giving particulars of new parts required, which are replaced from a stock which is maintained and based upon past experience.

The parts requiring repair are dealt with in the following manner:

Motion Pins (*Limit Gage*) —The limit gage system on motion is on the pin basis (owing to push and running fits being on one pin of one diameter). Tolerance on motion pins is 0.0005 in., the high diameter being the nominal diameter, the low diameter being the nominal diameter minus tolerance.

The motion pins are manufactured in nine different sizes, the first five varying 0.005 in. each and the remaining four vary 0.010 in. each, and each size is identified by a letter as follows:

	J	K	L	M	N	P	Q	R	S
High	2"	2.005	2.01	2.015	2.02	2.03	2.040	2.05	2.06
Low	1.9995	2.0045	2.0095	2.0145	2.0195	2.0295	2.0395	2.0495	2.0595

The pins are turned on automatics with an allowance of 0.010 in. to 0.015 in. for grinding after case hardening.

Hollow Motion Pins.—When these pins are worn below minimum size they are annealed and expanded by means of a press and mandrils: these mandrils run in sizes from No. 1 to No. 9, each varying in diameter 0.005 in. They are then rehardened and ground to size required. A substantial economy has been effected by this means.

Holes.—All rods are bushed with case-hardened bushes in rapidly wearing holes, and when worn the bush is pressed out and the new one inserted and ground to diameter required, which is governed by the size of hole in which the pin is fixed.

Limits.—The minimum variation allowed between pin and hole is that demanded for running fits, i. e., 0.0025 in. The maximum variation is 0.005 in., thus giving a manufacturing tolerance of 0.0025 in.

Reversing Shaft.—The journals of the reversing shafts wear slightly, and when worn oval to the extent of 0.010 in. they are turned up in lathe to graduated sizes, each varying 0.015 in., and when worn to the minimum diameter a sleeve bush is shrunk on and returned to standard size. Standard size of journal is 5 in., the minimum diameter is 4¼ in.

Reversing Shaft Carrier Bracket.—The bracket is bored out to allow for the fitting in of a cast iron sleeve bush; this diameter remains constant. The internal diameter of these bushes is machined to graduated sizes to suit the shaft journals. Worn bushes are re-bored to the nearest graduated size.

Radius Links.—These links wear mostly in the centre owing to the notching up when running; this necessitates them being ground parallel, and the radius blocks fitted to suit.

Radius Blocks.—Radius blocks are machined to four sizes, varying 0.015 in. each. After the blocks are fitted in the links a special fixture is used to mark the blocks while in position in the shaft, which ensures the holes being in line with the center of the shaft.

CHART SIZES OF RUNNING AND PUSH FITS

Running Fits

	J	K	L	M	N	P	Q	R	S
High	2.0045	2.0095	2.0145	2.0195	2.0245	2.0345	2.0445	2.0545	2.0645
Low	2.0025	2.0075	2.0125	2.0175	2.0225	2.0325	2.0425	2.0525	2.0625

Push Fits

	J	K	L	M	N	P	Q	R	S
High	2.0005	2.0055	2.0105	2.0155	2.0205	2.0305	2.0405	2.0505	2.0605
Low	2"	2.005	2.010	2.015	2.020	2.030	2.040	2.050	2.060

Reversing Screws.—The reversing screws are made in two

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*Taken from a paper on Management of a Locomotive Repair Shop, read before the Institution of Locomotive Engineers, England.

sizes, standard 2-in. diameter, and a 1/16-in. above. When these are worn thin on the thread they are scrapped.

Reversing Screw Nuts.—These are also made in two sides, standard and a 1/16-in. above. The reason for this is, when the standard nut has worn thin on the thread they are machined out a 1/16-in. larger in diameter, thus giving the nut another life.

Piston Rods.—Piston rods wear smaller in diameter at the middle than the ends, due to the friction of the packing. This necessitates them being ground to bring the rod parallel the whole of its length. They are ground in five graduated sizes, each varying 0.0312-in., standard size being 3-in. diameter, minimum diameter 2⅝ in. After the grinding operation the rod is then dealt with on the bench to have the crosshead and cotter fitted. Occasionally the crosshead has expanded leaving no cotter draw; in that case a crosshead is taken from stock and fitted, leaving a ⅛-in. draw. The old crosshead is placed in stock, and when new rods are being turned these crossheads are despatched to the lathe and the rods turned on cone to suit, thus getting the crosshead into service again.

Crosshead Gudgeon Pins (Effect).—Gudgeon pins are examined, and if worn more than 0.0312-in. on the little end or slide block bearing, they are renewed. These are made in two sizes on the slide block bearing, standard, and 1/16-in. above to give the slide block another life. They are manufactured on the automatics, case hardened and ground.

Piston Head.—The piston head, if found to have a clearance in the cylinder bore of 3/16-in., is condemned for that particular engine. Should the diameter of the head be over standard size, it is placed in stock and machined to suit the cylinder nearest to its diameter. The bore and cone portion for the piston rod bearing remains constant in all cases and is therefore interchangeable. Clearance allowed between cylinder bore and piston head for new or re-bored cylinder is 0.015-in.

Slide Blocks.—Slide blocks wear very slightly in the gudgeon pin hole; in cases where the wear exceeds 0.010-in. they are re-bored to 1/16-in. above standard size. This is sufficient to wear the block and flange to their minimum thickness.

Slide Valve Spindles.—The flat valve type of spindle, when in for repairs, is generally found to have expanded at the buckle, and if this expansion exceeds 0.015-in. above standard, it is sent to the smithy for closing, and there machined up to standard in the buckle. Should the spindle have worn below the minimum diameter a new end is welded on to the buckle and machined to the standard diameter.

The standard diameter of the spindle is 2⅛ in. As the spindle wears more in the center than at the end, due to the friction of the packing, this necessitates it being ground to bring the rod parallel the whole of its length.

They are ground to nine graduated sizes, varying 0.015-in. from 2⅛-in. diameter to 2-in.

Valve Spindle Crosshead.—The same remarks apply to fitting of crosshead to spindle as in the piston rod.

Valve Spindle and Piston Packing.—Packings are manufactured in graduated sizes in conformity with piston rod sizes.

Cab Details.—The injectors are stripped of all cones and plugs; scale removed from body and cones. Valve seatings and cones are re-faced and adjusted.

Steam Valve and Tappet Valve Seatings.—Due to the constant wear and repeated cuttings of the seatings, they rapidly become worn out. In order to increase the life of the body it is bored out and a bush fitted as a renewable seat.

Pipe Ends.—Occasionally the thread on pipe ends becomes stripped; these are restored to standard by turning the ends down and sweating on a sleeve bush, afterwards re-cutting the thread. After injectors are repaired they are tested for efficiency in lift and delivery.

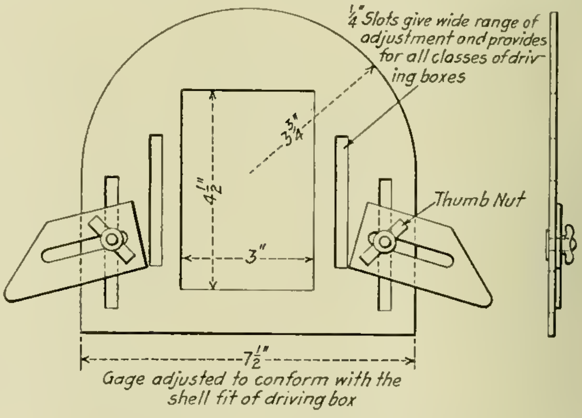
Ejectors.—The ejector is stripped of all plugs and cones, thoroughly cleaned and examined, and cones that have been cut due to action of the steam are re-turned and adjusted. In all wearing parts renewable seatings are fitted wherever possible. The disc plate requires turning up and facing to the driver's application handle. All glass gage cocks, lubricator cocks, etc., are stripped, examined and new plugs fitted where required. In cases of taper plugs they are ground only. Parallel plugs are ground and asbestos packed.

Driving Box Gage

BY A. W. C.

It is highly important that the crown brass of a driving box should be a good tight fit in the box, and this requires that the brass properly bears on the small angular surfaces as well as on the curved surface or back of the shell. If these requirements are not met, the brass will very easily work loose and become a source of trouble and annoyance. When an old brass has been removed, it is a rather difficult matter to measure the small angular surfaces, and their distance from the crown of the box, and then lay out these measurements on the shell. After being some years in service and having had various repairs made to them, driving boxes vary considerably, so that each brass must be made to fit its particular box, and the edges are not planed to any standard dimensions.

An expedient commonly resorted to in many repair shops and roundhouses, is to place the brass on end on the box, in a position as near as possible to that which it will occupy in the box; that is, with the back of the brass in line with the crown surface of the box. The outlines of the angular surfaces are then scribed on the brass, which is planed to these lines, and pressed into the box with somewhat doubtful results. A simple, adjustable gage, as illustrated, can be made easily and used for accurately transferring the outlines of the angular surfaces on the box to the brass.



Efficient Form of Driving Box Gage

The gage is made of ⅛ in. sheet steel to the dimensions shown. The two wings or blades are attached to the body of the gage by ¼ in. carriage bolts and wing nuts. In use, the curved portion of the gage is placed against the crown of the driving box, and the blades are adjusted to bear on the angular surfaces in the box, being secured in that position by tightening the thumb nuts. The gage is then placed on the end of the brass, with the curved portion flush with the back of the brass. The outlines of the blades are scribed on the brass, thus faithfully reproducing the dimensions of the driving box brass fit. It is obvious that this saves handling the heavy driving boxes and brasses now in use and affords a far better method for getting a good fit.

Notes on General Shop Practice at Du Bois

Production Is Increased and Unit Costs Decreased By Using Present Equipment to the Best Advantage

BY GEORGE W. ARMSTRONG

Many interesting and effective methods have been developed at the Du Bois shops of the Buffalo, Rochester & Pittsburgh, each one a real factor in increasing the efficiency of shop operation. Careful attention to details, elimination of much lost motion and the equipment of machines with time saving jigs and fixtures all help to increase shop output and reduce the unit costs of repair work.

The driving box equipment represents a good use of old tools for single purpose production. For machining crown brasses to fit driving boxes, a slotter (Fig. 1) has been equipped with the customary holding mandrel; the stroke has been lengthened to take brasses for extended main driving boxes and a simple, heavy feed suitable for brass cutting applied. Rapid finishing of the brasses is assured by these comparatively simple, inexpensive changes in the slotter.

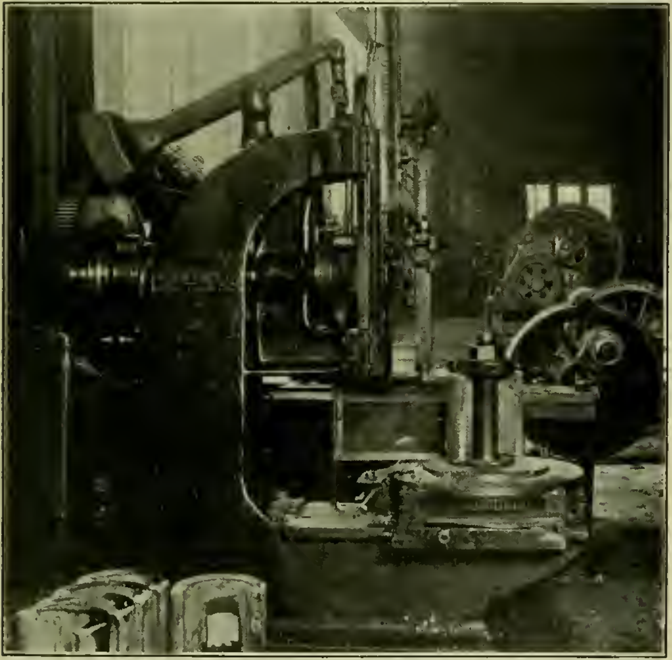


Fig. 1—Slotter Arranged for Rapid Machining of Crown Brasses

Driving boxes are bored and hub liners faced on a boring mill (Fig. 2) which has been equipped with a piloted boring bar to provide rigidity and permit the taking of heavy cuts. Hub liners are faced by the second head, thus performing two operations at one setting of the driving box and making sure that the hub face is at right angles to the bore of the box. Driving box shoe and wedge ways are kept a standard width by electric welding steel liners along the driving box flanges. The edges of the liners where they are welded to the driving box are beveled, an operation cheaply performed by planing a number of liners at the same time. They are held at the proper angle in a planer chuck using suitable beveled blocks and feeding the tool across all the liners at once. To assist in holding the liners six holes are punched for "tack-welding." After welding, the driving boxes are planed to the standard widths between shoe and wedge faces called for by the blue prints.

Washout plugs are quickly and accurately turned and threaded in an engine lathe (Fig. 3). Several sizes of castings are carried so as to reduce the amount of metal to be removed to an economical minimum, about 1/8 in. range being cared for by each casting. The small end of the plug is cored out to a bell shape to reduce the weight and permit quick center punching for the tail stock center.

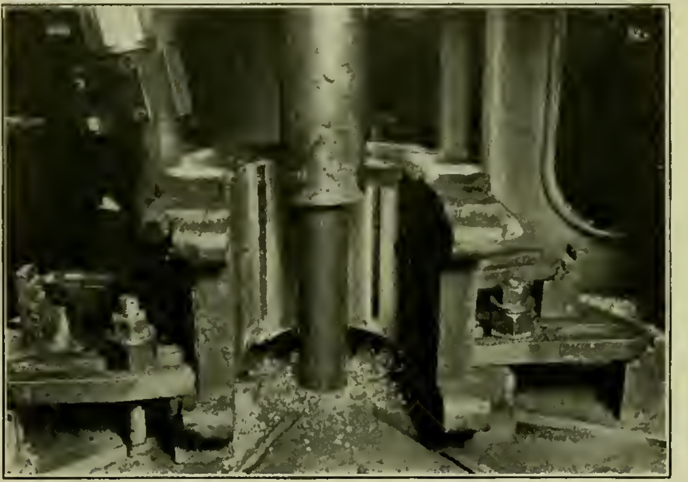


Fig. 2—Heavy Cuts Are Taken With a Piloted Boring Bar

The threading tool is a hobbed chaser (as shown on top of the tool post) held in a block fitted to take the place of the regular tool post. Grinding this tool at an angle furnishes a turning edge to precede the threading chaser. By means of an adjustable stop, the carriage travel can be regulated, permitting the taking of several cuts and yet maintaining the size where a number are made of the same size. The taper is obtained by setting over the tail stock, as this method has been found to give the best results. The strips, shown at an angle on the side of the tool block, have been provided to hold the hinged guard, protecting the workman from flying


Fig. 3—Method of Machining Washout Plugs

brass chips. The average production, working on a quantity shop order, is 100 plugs in eight hours.

An interesting method of solving a difficult shop problem is illustrated by the fixture for turning lift shaft bearings (Fig. 4). This is one of the troublesome jobs in the average shop, owing to the long arms requiring a large swing lathe to turn them. Such a lathe in many cases is not available and as a result, the bearings are filed, a lengthy operation that does not produce accurate work. The special fixture illustrated has been devised and is fastened to the lathe face plate. It consists of a sleeve carrying a turning tool, capable of sliding lengthwise and keyed to a center portion, which also has a live center. The lift shaft is placed between the center in the fixture and the lathe dead center. Both the lift shaft and the outer end of the fixture are held by steady rests. Turning up to a capacity of 6 in. in diameter by 16 in. in length can be done by moving the turning sleeve with the tool bit along the shaft; such traversing motion being caused by a lathe tool engaged in a slot in the sliding sleeve.

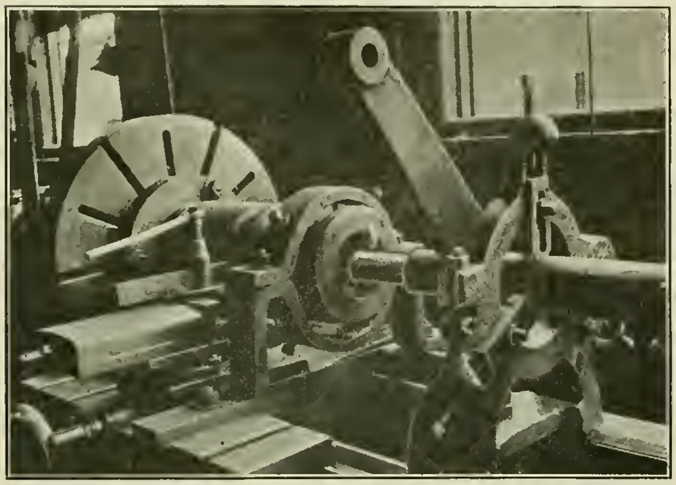


Fig. 4—Fixture for Turning Lift Shaft Bearings

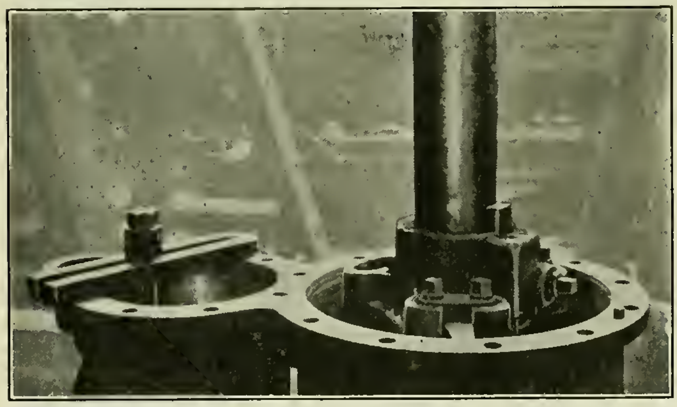


Fig. 5—Adjustable Head Used in Boring Air Compressor Cylinders

Fig. 6—Folding Screens are a Convenient and Effective Safety Device

Air compressor cylinders are accurately and quickly bored on a radial drill press (Fig. 5), the steam cylinder of an 8½ in. cross compound compressor being shown. A regular boring tool through the bar is used for the small bore cylinders, the adjustable boring head being used for the 14½ in. cylinders. The boring bar is maintained rigid by a pilot bracket bolted to the side of the drill press table. As illustrated, a clamping bolt and cross iron through one cylinder allows the other cylinder to be swung over the side of the drill press table and the boring bar extends through the cylinder to the pilot bracket. A roughing feed of .009 in. and finishing feed of .006 in. are used.

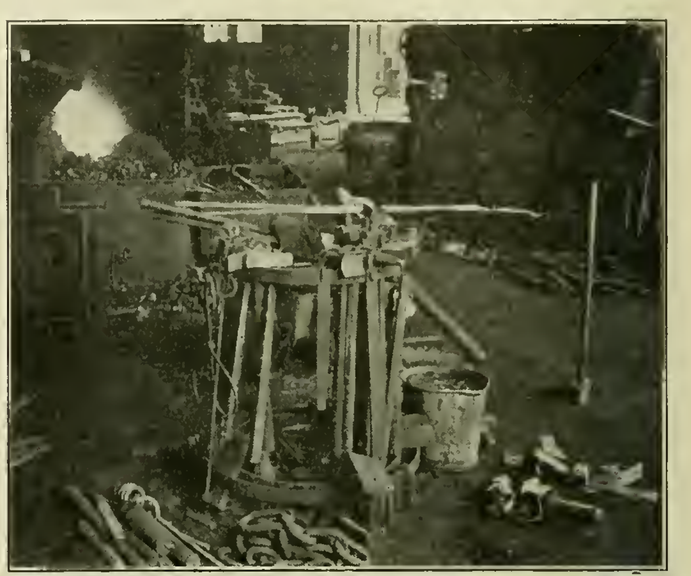


Fig. 7—Handy Tool Rack With Sheet Iron Drawer

Fig. 8—Fixture Used in Rolling Boilers

Safeguards are everywhere in evidence in the Du Bois shops, indicative of the vigilance of the men on the safety committee, who make a general inspection of the shop every other Saturday afternoon. One very simple and valuable safety device is the screen (Fig. 6) used around vises where much chipping and filing is done, especially in the rod department. These screens when not in use can readily be folded back out of the way.

A good blacksmith shop tool rack has been devised (Fig. 7) which keeps the tools readily available and near the anvil where wanted. It consists of two concentric circles of 1½ in. by ¼ in. iron separated as shown, one pair forming the top and the other the bottom of the tool rack. A sheet iron drawer is provided in the center for keeping orders, time books, etc. It is difficult to say just how many steps and how much time are saved each day by having tools and working implements right at hand ready for use.

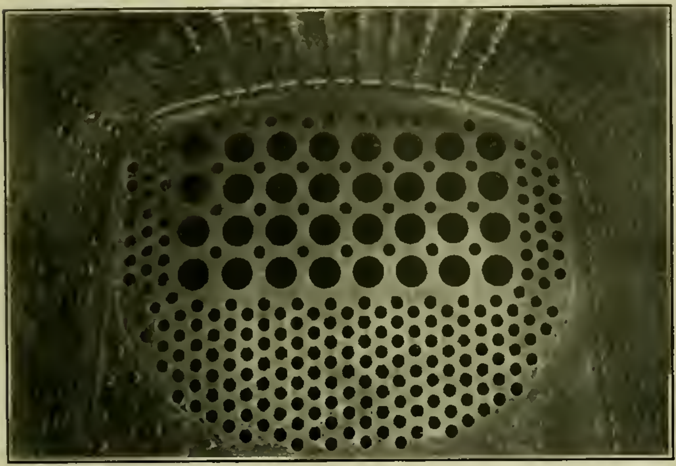


Fig. 9—Application of New Flue Hole Portion to Back Flue Sheet

Rolling boilers is quickly and easily accomplished by the fixture illustrated in Fig. 8. The boiler is slung from the main hoist hook with the steel shackle bar under the belly of the boiler. Turning to any desired position is accomplished by the cable attached to the auxiliary hoist hook.

The practice of electric welding has come into general use at Du Bois and shows excellent results, especially on boiler work. A large number of fireboxes have been applied with complete electric welded seams, except at the top of the back tube sheet, where it has been found more satisfactory to rivet to the crown sheet. Back heads are welded in completely, including the door holes. Where flue sheets require replacing solely because of cracked bridges or where a change is made from saturated to superheated steam, the flue hole portion is cut out by the torch and a new section welded in place (Fig. 9), thus requiring no renewal of staybolts or driving of mud ring rivets. Side sheets requiring renewal because of enlarged staybolt holes, or other causes except defective seams, are renewed by electrically welding a new section in place.

T. O. Edwards, auditor of the Southern Pacific, discovering that a number of employees of the road have lost Liberty Bond savings and other "nest eggs" through misrepresentation of unscrupulous promoters, has issued the following warning: "No matter how attractive the proposition may seem to be on the surface, employees, before investing their savings, should consult with some responsible banker in their community who will gladly give them frank and unbiased advice, whether they are a patron of the bank or not. There are many opportunities for sound and profitable investments at the present time, but attempts are being made every day to defraud the public and impose upon the credulous."

Chuck for Holding Hose Nuts

By J. M. Cairns
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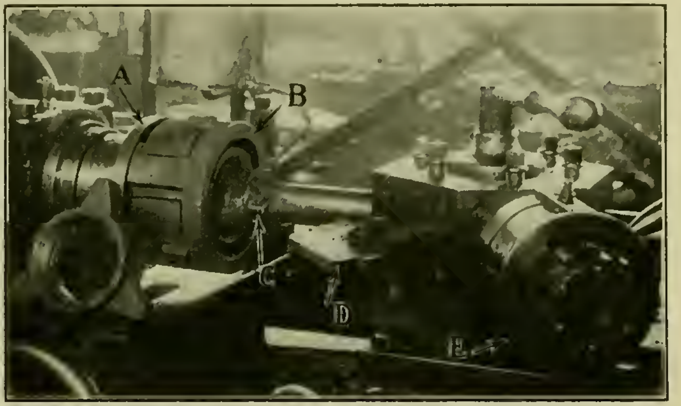
In most railroad shops a large number of hose nuts have to be machined either for local use or for other points on the system. In the quantity production of hose nuts, as all other locomotive parts, a small amount of time saved on each one means a large total saving which is well worth while. The special chuck, illustrated and described in this article, is designed to save part of the time formerly spent truing up and centering hose nuts in ordinary chucks of either the independent or universal type.

The operation of the chuck is extremely simple. As shown in the illustration, it consists of a nut holder *A* arranged to screw on the lathe spindle and slotted to receive the lugs of the nut. The ring *B* is arranged to telescope the nut holder and a partial turn engages three shoulders which prevent its slipping off again.



Special Chuck and Turret Lathe Tooling Arrangement for Machining Hose Nuts

The lathe used is a well-known type of 18 in. brass turret lathe, equipped with an internal plunger, or spindle, controlled by a lever at the head end. In operation, the hose nut is put in place with the holding ring applied and turned in the locking position. The lever is pulled back, forcing the internal plunger against the back of the nut, thus automatically locking the ring and holding the nut in a firm grip.

Hose nuts are made of malleable iron in two sizes, 3¾ in., 8 thread, and 4 in., 8 thread. They are roughed out with the boring tool *C*, the finishing size being attained by a forming drill *D*. The final operation consists of tapping out with a collapsible tap *E*, thus reducing to a minimum the total time required for setting up and machining a hose nut.

Instructions for Grinding Chilled Cast Iron Car Wheels

The following instructions and the accompanying tables, embodying the Atchison, Topeka and Santa Fe practice in grinding chilled cast iron car wheels, are abstracted from the 1920 Proceedings of the American Railroad Association, Section III—Mechanical.

The original tape size of a chilled iron wheel is shown by the number of small lugs on the back of the wheel. Wheels sent in for grinding must be taped with the standard A. T. & S. F. tape, which has special graduations for measuring worn wheels which are smaller than a Tape 1 wheel, and the original tape size must also be noted. Then, by referring to the table under the original tape size, and reading across from the actual tape size of the wheel as measured, the diameter, circumference and depth of chill can be found. If the wheel is slid flat the flat spot must also be measured and under the column headed "Length of Flat Spot" will be found the diameter and tape to which the wheel must be ground. The depth of chill after grinding can be determined by referring to the chill corresponding to the reduced tape size.

Wheels with worn treads can be ground if the measured tape size is shown above the heavy line on the table for the original tape size of the wheel. Skidded wheels should have the greatest flat spot measured, and the wheel must then be ground the same as for a slid flat wheel as described above. In no case are slid flat wheels to be ground if the tape size and diameter necessary for grinding are under the heavy line in the table for the original size of the wheel. The flanges of wheels that have been ground must not exceed the maximum allowance of 1⅛ in. in height. If the flanges are over this limit they must be ground also.

Reference to the tables will show that X, X/1, X/2, X/3, etc., are markings on the standard Sante Fe tape, made for convenience in measuring worn wheels and corresponding to the definite diameters, 32⅞ in., 32 27/32 in., 32 51/64 in., 32 49/64 in., etc., respectively.

Examples

Slid Flat.—An original tape 2 wheel which measures X/3 and has a 3¼ in. flat spot must be ground to tape X/7, or 32 39/64 in. in diameter. The chill is 9/16 in., which is reduced by grinding to 31/64 in.

Tread Worn.—An original tape 3 wheel which measures X/2 on re-taping would grind to X/2 but could not be ground if the re-taped size fell below the minimum, or X/8.

Tape Size	Diameter In.	Circular	Chill In.	GRINDING DIAMETER FOR SLID FLAT WHEELS — DIMENSIONS AT TOP OF COLUMNS INDICATE LENGTHS OF FLAT SPOTS.																											
				2″		2¼″		2½″		2¾″		3″		3¼″		3½″		3¾″		4″		4¼″		4½″		4¾″		5″		5¼″	
				Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.
1	32 59/64	103.42	23/32	X/1	32 55/64	X/1	32 27/32	X/1	32 53/64	X/2	32 51/64	X/2	32 25/32	X/3	32 49/64	X/4	32 47/64	X/5	32 45/64	X/5	32 43/64	X/6	32 41/64	X/7	32 39/64	X/8	32 37/64	X/9	32 35/64	X/9	32 33/64
X	32 7/8	103.29	45/64	X/2	32 13/16	X/2	32 51/64	X/3	32 25/32	X/3	32 49/64	X/3	32 3/4	X/4	32 23/32	X/5	32 11/16	X/6	32 21/32	X/7	32 5/8	X/7	32 19/32	X/8	32 9/16	X/9	32 17/32	X/10	32 1/2		
X/1	32 27/32	103.17	43/64	X/3	32 25/32	X/3	32 49/64	X/3	32 3/4	X/4	32 23/32	X/5	32 45/64	X/5	32 11/16	X/6	32 21/32	X/7	32 5/8	X/7	32 19/32	X/8	32 9/16	X/9	32 17/32	X/10	32 1/2				
X/2	32 51/64	103.05	21/32	X/4	32 47/64	X/4	32 23/32	X/5	32 45/64	X/5	32 43/64	X/5	32 21/32	X/6	32 41/64	X/7	32 39/64	X/8	32 37/64	X/9	32 35/64	X/9	32 33/64	X/10	32 31/64						
X/3	32 49/64	102 92	41/64	X/5	32 45/64	X/5	32 11/16	X/5	32 43/64	X/6	32 41/64	X/7	32 5/8	X/7	32 39/64	X/8	32 37/64	X/9	32 35/64	X/9	32 33/64	X/10	32 31/64								
X/4	32 23/32	102.80	39/64	X/6	32 21/32	X/5	32 41/64	X/7	32 5/8	X/7	32 19/32	X/3	32 37/64	X/8	32 9/16	X/9	32 17/32	X/10	32 1/2												
X/5	32 11/16	102.67	19/32	X/7	32 5/8	X/7	32 39/64	X/7	32 19/32	X/8	32 9/16	X/9	32 35/64	X/9	32 17/32	X/10	32 1/2														
X/6	32 41/64	102 55	37/64	X/8	32 37/64	X/8	32 9/16	X/9	32 35/64	X/9	32 33/64	X/10	32 1/2																		
X/7	32 39/64	102 42	9/16	X/9	32 35/64	X/9	32 17/32	X/9	32 33/64	X/10	32 31/64																				

Tape 1—Original

				2″		2¼″		2½″		2¾″		3″		3¼″		3½″		3¾″		4″		4¼″		4½″		4¾″		5″		5¼″		5 ½	
2	32 61/64	103.54	21/32	X	32 57/64	X	32 7/8	X/1	32 55/64	X/1	32 53/64	X/2	32 13/16	X/2	32 51/64	X/3	32 49/64	X/4	32 47/64	X/5	32 45/64	X/4	32 43/64	X/6	32 41/64	X/7	32 39/64	X/8	32 37/64	X/9	32 17/32	X/10	32 31/32
1	32 59/64	103.42	41/64	X/1	32 55/64	X/1	32 27/32	X/1	32 53/64	X/2	32 51/64	X/3	32 25/32	X/3	32 49/64	X/4	32 47/64	X/6	32 45/64	X/5	32 43/64	X/6	32 41/64	X/7	32 39/64	X/8	32 37/64	X/9	32 35/64	X/9	32 33/64	X/10	32 15/32
X	32 7/8	103.29	5/8	X/2	32 13/16	X/2	32 51/64	X/3	32 25/32	X/3	32 49/64	X/3	32 3/4	X/4	32 23/32	X/5	32 11/16	X/6	32 21/32	X/7	32 5/8	X/7	32 19/32	X/8	32 9/16	X/9	32 17/32	X/10	32 1/2				
X/1	32 27/32	103.17	19/32	X/3	32 25/32	X/3	32 49/64	X/3	32 3/4	X/4	32 23/32	X/5	32 45/64	X/5	32 11/16	X/5	32 21/32	X/7	32 5/8	X/7	32 19/32	X/8	32 9/16	X/9	32 17/32	X/10	32 1/2						
X/2	32 51/64	103.05	37/64	X/4	32 47/64	X/4	32 23/32	X/5	32 45/64	X/5	32 43/64	X/6	32 21/32	X/6	32 41/64	X/7	32 39/64	X/8	32 37/64	X/9	32 35/64	X/9	32 33/64	X/10	32 31/64								
X/3	32 49/64	102.92	9/16	X/5	32 45/64	X/5	32 11/16	X/5	32 43/64	X/6	32 41/64	X/7	32 5/8	X/7	32 39/64	X/8	32 37/64	X/9	32 35/64	X/9	32 33/64	X/10	32 31/64										
X/4	32 23/32	102.80	35/64	X/6	32 21/32	X/6	32 41/64	X/7	32 5/8	X/7	32 19/32	X/8	32 37/64	X/8	32 9/16	X/9	32 17/32	X/10	32 1/2														
X/5	32 11/16	102.67	17/32	X/7	32 5/8	X/7	32 39/64	X/7	32 19/32	X/8	32 9/16	X/9	32 35/64	X/9	32 17/32	X/10	32 1/2																
X/6	32 41/64	102.55	1/2	X/8	32 37/64	X/8	32 9/16	X/9	32 35/64	X/9	32 33/64	X/10	32 1/2																				
X/7	32 39/64	102.42	31/64	X/9	32 35/64	X/9	32 17/32	X/9	32 33/64	X/10	32 31/64																						

Tape 2—Original

Tables Used on the Atchison, Topeka & Santa Fe to Determine Whether Chilled Iron Car Wheels Can Safely Be Ground

Grinding Diameter for Slid Flat Wheels — Dimensions at Top of Columns Indicate Lengths of Flat Spots.

Tape Size	Diameter In.	Circular	Chill In.	2"		2¼"		2½"		2¾"		3"		3¼"		3½"		3¾"		4"		4¼"		4½"		4¾"		6"		5¼"		5½"		6¾"	
				Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.	Tape	Dia. In.
3	33	103.67	7/16	2	32[illegible]	1	32[illegible]	1	32[illegible]	×	32⅞	×-1	32[illegible]	×-1	32[illegible]	×-2	32[illegible]	×-3	32[illegible]	×-3	32¾	×-4	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-7	32⅝	×-8	32[illegible]	×-9	32[illegible]		
2	32[illegible]	103.54	[illegible]	×	32[illegible]	×	32⅞	×-1	32[illegible]	×-1	32[illegible]	×-2	32[illegible]	×-2	32[illegible]	×-3	32[illegible]	×-4	32[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-7	32[illegible]	×-8	32[illegible]	×-9	32[illegible]				
1	32[illegible]	103.42	[illegible]	×-1	32[illegible]	×-1	32[illegible]	×-1	32[illegible]	×-2	32[illegible]	×-2	32[illegible]	×-3	32[illegible]	×-4	32[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-7	32[illegible]	×-8	32[illegible]	×-9	32[illegible]						
×	32⅞	103.29	½	×-2	32[illegible]	×-2	32[illegible]	×-3	32[illegible]	×-3	32[illegible]	×-3	32¾	×-4	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-7	32⅝	×-7	32[illegible]	×-8	32 9/16	×-9	32½								
×-1	32[illegible]	103.17	[illegible]	×-3	32[illegible]	×-3	32[illegible]	×-3	32¾	×-4	32[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-7	32⅝	×-7	32[illegible]	×-8	32 9/16	×-9	32[illegible]										
×-2	32[illegible]	103.05	[illegible]	×-4	32[illegible]	×-4	32[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-6	32[illegible]	×-7	32[illegible]	×-8	32[illegible]	×-9	32[illegible]														
×-3	32[illegible]	102.92	[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-7	32⅝	×-7	32[illegible]	×-8	32[illegible]	×-9	32[illegible]																
×-4	32[illegible]	102.80	[illegible]	×-6	32[illegible]	×-6	32[illegible]	×-7	32⅝	×-7	32[illegible]	×-8	32[illegible]	×-8	32 9/16	×-9	32½																		
×-5	32[illegible]	102.67	[illegible]	×-7	32⅝	×-7	32[illegible]	×-7	32[illegible]	×-8	32 9/16	×-9	32[illegible]																						
×-6	32[illegible]	102.55	[illegible]	×-8	32[illegible]	×-8	32 9/16	×-9	32[illegible]																										

Tape 3—Original

4	33[illegible]	103.80	[illegible]	3	32[illegible]	2	32[illegible]	2	32[illegible]	1	32[illegible]	1	32[illegible]	×	32[illegible]	×-1	32[illegible]	×-1	32[illegible]	×-2	32[illegible]	×-3	32[illegible]	×-4	32[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-7	32⅝	×-8	32[illegible]	×-9	32[illegible]
3	33	103.67	[illegible]	2	32[illegible]	1	32[illegible]	1	32[illegible]	×	32⅞	×-1	32[illegible]	×-1	32[illegible]	×-2	32[illegible]	×-3	32[illegible]	×-3	32¾	×-4	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-7	32⅝	×-8	32[illegible]	×-9	32[illegible]		
2	32[illegible]	103.54	[illegible]	×	32[illegible]	×	32⅞	×-1	32[illegible]	×-1	32[illegible]	×-2	32[illegible]	×-2	32[illegible]	×-3	32[illegible]	×-4	32[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-7	32[illegible]	×-8	32[illegible]	×-9	32[illegible]				
1	32[illegible]	103.42	[illegible]	×-1	32[illegible]	×-1	32[illegible]	×-1	32[illegible]	×-2	32[illegible]	×-3	32[illegible]	×-3	32[illegible]	×-4	32[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-7	32[illegible]	×-8	32[illegible]								
×	32⅞	103.29	[illegible]	×-2	32[illegible]	×-2	32[illegible]	×-3	32[illegible]	×-3	32[illegible]	×-3	32¾	×-4	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-7	32⅝	×-7	32[illegible]	×-8	32 9/16										
×-1	32[illegible]	103.17	7/16	×-3	32[illegible]	×-3	32[illegible]	×-3	32¾	×-4	32[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-7	32⅝	×-7	32[illegible]	×-8	32 9/16												
×-2	32[illegible]	103.05	[illegible]	×-4	32[illegible]	×-4	32[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-6	32[illegible]	×-7	32[illegible]	×-8	32[illegible]																
×-3	32[illegible]	102.92	[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-7	32⅝	×-7	32[illegible]	×-8	32[illegible]																		
×-4	32[illegible]	102.80	⅜	×-6	32[illegible]	×-6	32[illegible]	×-7	32⅝	×-7	32[illegible]	×-8	32[illegible]	×-8	32 9/16																				

Tape 4—Original

5	33[illegible]	103.92	½	3	33[illegible]	3	33	3	32[illegible]	2	32[illegible]	2	32[illegible]	1	32[illegible]	×	32[illegible]	×-1	32[illegible]	×-1	32[illegible]	×-2	32[illegible]	×-3	32[illegible]	×-4	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-7	32[illegible]	×-8	32[illegible]
4	33[illegible]	103.80	[illegible]	3	32[illegible]	2	32[illegible]	2	32[illegible]	1	32[illegible]	1	32[illegible]	×	32[illegible]	×-1	32[illegible]	×-1	32[illegible]	×-2	32[illegible]	×-3	32[illegible]	×-4	32[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-7	32⅝	×-8	32[illegible]	×-9	32[illegible]
3	33	103.67	[illegible]	2	32[illegible]	1	32[illegible]	1	32[illegible]	×	32⅞	×-1	32[illegible]	×-1	32[illegible]	×-2	32[illegible]	×-3	32[illegible]	×-3	32¾	×-4	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-7	32⅝	×-8	32[illegible]	×-9	32[illegible]		
2	32[illegible]	103.54	7/16	×	32[illegible]	×	32⅞	×-1	32[illegible]	×-1	32[illegible]	×-2	32[illegible]	×-2	32[illegible]	×-3	32[illegible]	×-4	32[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-7	32[illegible]	×-8	32[illegible]	×-9	32[illegible]				
1	32[illegible]	103.42	[illegible]	×-1	32[illegible]	×-1	32[illegible]	×-1	32[illegible]	×-2	32[illegible]	×-3	32[illegible]	×-3	32[illegible]	×-4	32[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-7	32[illegible]	×-8	32[illegible]								
×	32⅞	103.29	[illegible]	×-2	32[illegible]	×-2	32[illegible]	×-3	32[illegible]	×-3	32[illegible]	×-3	32¾	×-4	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-7	32⅝	×-7	32[illegible]	×-8	32 9/16										
×-1	32[illegible]	103.17	[illegible]	×-3	32[illegible]	×-3	32[illegible]	×-3	32¾	×-4	32[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-7	32⅝	×-7	32[illegible]	×-8	32 9/16												
×-2	32[illegible]	103.05	[illegible]	×-4	32[illegible]	×-4	32[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-6	32[illegible]	×-7	32[illegible]																		
×-3	32[illegible]	102.92	[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-5	32[illegible]	×-6	32[illegible]	×-7	32⅝	×-7	32[illegible]	×-8	32[illegible]																		

Tape 5—Original

Tables Used on the Atchison, Topeka & Sante Fe to Determine Whether Chilled Cast Iron Car Wheels Can Safely Be Ground

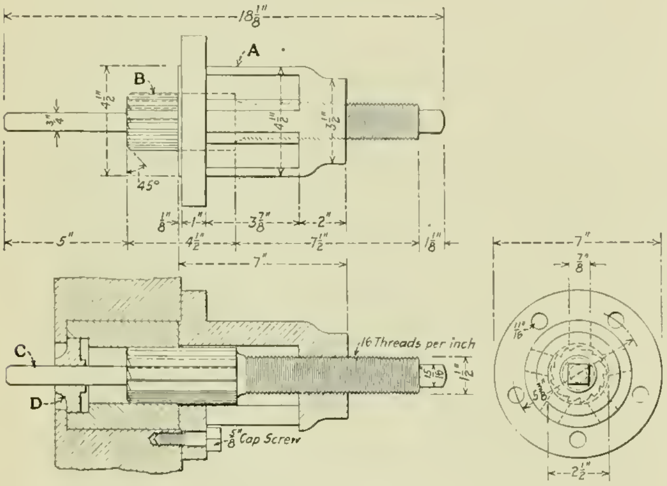
Reaming Reversing Valve Bushings

BY CHARLES W. SCHANE

Apprentice Instructor, Erie Repair Shops, Huntington, Ind.

The jig illustrated herewith has proved an effective device for reaming worn reversing valve bushings in the steam heads of New York air compressors. The bushings can be reamed without removing the compressor from the engine or taking off the steam head and on account of this feature, the device has proved of great value in saving time at roundhouses and reducing the number of air compressor failures. A pair of reversing valve bushings can be reamed and new packing rings fitted and applied in an hour's time by one machinist.

As shown in the illustration, the jig consists of a body *A* arranged to be fastened to the under side of the steam head in place of the reversing valve cap by means of five 5/8 in. cap screws. The reamer *B* is made in one solid piece with one end threaded to advance the reamer, the extreme end being squared for a wrench. The other end consists of a piloting stem 3/4 in. in diameter. In operation, the jig is attached to the under side of the steam head, being held securely in place by the cap screws. The reamer is guided by the piloting stem *C* which is a running fit in bushing *D*. As the reamer is turned, it advances into the bushing and when fed in the full distance, leaves a smooth, true hole to which the reversing valve packing rings may be fitted.



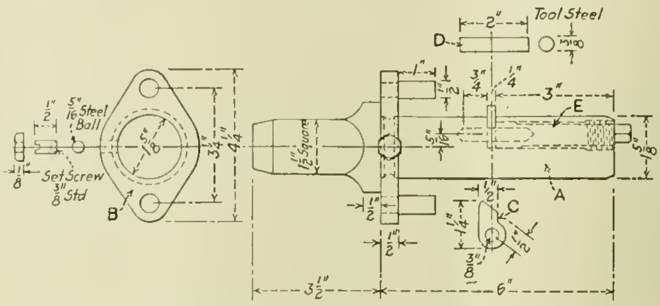
Device for Reaming Reversing Valve Bushings

On account of the reaming action being upward, the chips fall out of the valve chamber into the body of the jig and may be brushed away through the apertures shown. This prevents any possibility of chips getting into the valves of cylinders of the air compressor.

Liberty Flue Cutter

A device known as the Liberty flue cutter has given exceptionally satisfactory service in the Horton shops of the Chicago, Rock Island & Pacific for cutting out flues in front ends. Referring to the illustration, mandrel *A* is made of tool steel, slightly less than 1 5/8 in. in diameter and provided with a 1 1/2 in. square end for driving. Plate *B*, made of 1/2 in. stock, is arranged to turn freely on the mandrel and form a positive stop when the mandrel is inserted in the boiler flue. Plate *B* is held against the shoulder on the mandrel and allowed to turn freely by means of the steel ball, 3/8 in. set screw, and lock nut as shown, the steel ball rolling in a groove in the mandrel *A*.

The cutting knife *C* is made of carbon steel shaped as indicated with a shoulder to take the direct thrust and arranged to be held in the mandrel *A* by means of the steel pin *D*. The slight radius at the point of the knife *C* makes possible a shearing action which shears the thickness of the flue and width of the knife in one revolution from the time the knife begins to cut. Very little power is required for this operation. The steel pin *D* is held in place by means of pin holder *E* which is also made of tool steel. All wearing parts of the Liberty flue cutter are case hardened to increase their resistance to wear.



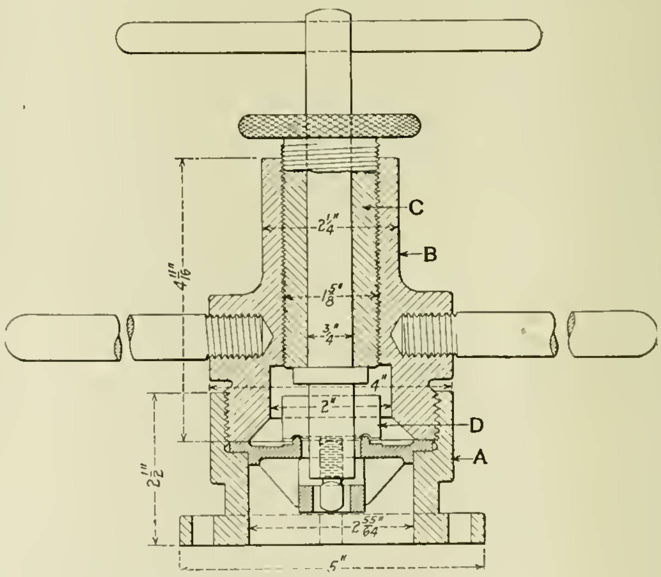
An Effective, Easily Made Flue Cutter

Emergency Seat Refacing Tool

BY JOHN FLINNER

Air Brake Inspector, Pittsburgh & Lake Erie, McKeesport, Pa.

A special tool designed to reface the brass seats of emergency valves applied to Westinghouse triple valves of either the passenger or freight type is shown in the illustration. The emergency valve seat is placed in the base *A* of the fixture as shown. Part *B*, provided with two handles, is arranged to turn into the base *A*, holding the brass emergency valve seat firmly in place. An adjusting screw *C* may be turned down by hand against a shoulder on the valve stem carrying the cutting tool *D*. This cutting tool is double acting, so ground as to give the required shape to the valve seat. It is held in place by means of a square-headed set screw as shown.



Tool for Refacing Emergency Valve Seats

This emergency valve seat refacing tool has been used with good results as it makes possible the refacing of valve seats that become worn or cut in service. In addition, old style valve seats may be refaced, giving them the improved semi-circular section shown, which has been found to give better service.

A Profitable Railroad Reclamation Project

170 Tons of Bar Iron a Month Rolled From Bundled Scrap at Beech Grove Shops of the "Big Four"

ESTABLISHED early in 1918 for the purpose of re-rolling bar scrap, the rolling mill at the Beech Grove (Indianapolis, Ind.) shops of the Cleveland, Cincinnati, Chicago & St. Louis has since been adapted to the reclamation of miscellaneous wrought iron scrap at a materially greater profit than was realized under the original re-rolling practice.

The rolling mill was placed in operation in April, 1918, at a time when materials of all kinds were exceedingly difficult to secure. The railroad had on hand a large accumulation of scrap, including considerable quantities of old truss rods, arch bars and other miscellaneous material of rectangular cross section, suitable for re-rolling into useful bar stock.

Rear View of the Mill Showing the Cooling Bed and the Jib Crane for Handling the Finished Bars

At the outset the mill was operated along conventional lines of re-rolling practice. Both the roughing and finishing rolls were fitted with the usual alternate oval and circular passes. Heating and re-rolling were the only operations performed on round iron, while flat sections were split before being rolled.

Several stages of development were passed through before the present practice was established. One of these was the use of splitting rolls on the roughing side of the mill, so that flat sections might be split hot and re-rolled at the same time. This practice, however, did not always eliminate the necessity of reheating half of the split material before it could be rolled and saved only the shearing operation. During the early history of the plant some attention was given to the production of rectangular sections in the rolls but considerably greater difficulties are encountered in the operation of the mill on rectangular work than in the production of circular sections. As the demand for round bar stock is great enough to keep the mill busy, its operation is now confined exclusively to the production of that class of material.

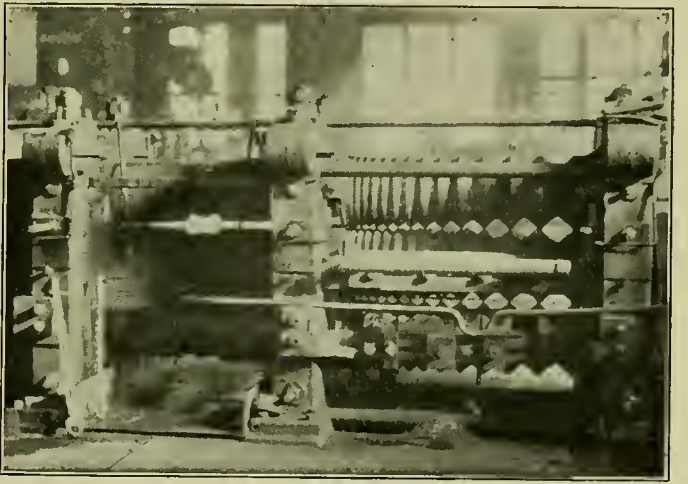
A careful study of the operation of the mill developed the fact that, under the local conditions, the profit was not large from strictly re-rolling operations. Under the present method of operation the rolling mill serves as a means of reclaiming practically all of the miscellaneous wrought iron scrap accumulating on the road. Scrap iron bars and trimmings of all sizes are sheared and bundled and then rolled into round bar stock ranging from ⅝ in. to 1½ in. in diameter, practically supplying the needs of the railroad for this class of material, at an average monthly net profit of over $3,500.

The Rolling Mill Equipment

The rolling mill is located in the blacksmith shop and occupies a total floor space of approximately 45 ft. by 120 ft. The equipment consists of an Ajax B, 14-in. mill driven by a 100-hp. motor, a shop built furnace with double heating chambers each measuring 7 ft. by 5 ft. 6 in. inside, hot tables for the roughing and finishing rolls on the furnace side of the mill, a metal floor and a straightening bed of old rails at the back side of the mill.

The furnace is 18 ft. in length and the two heating chambers are separated by a partition wall. Each chamber is heated by two oil burners, the two sets of burners being located at opposite ends of the structure. The four burners consume about 48 gal. of oil an hour. Each heating chamber is provided with two door openings and normally its charge consists of 12 bundles of scrap. Both ends of the furnace are used continuously; a fresh charge is heating in one end while that in the other is being rolled.

The present operation of the mill on bundled scrap was made possible by the adoption of the so-called Gothic roughing rolls. The characteristic form of the passes in these rolls is shown in one of the illustrations. The rolls were cast in a local steel foundry, of electric steel poured around cores of steel rails, and were machined in the railroad shops.



The Roughing Rolls, Showing the Form of the Gothic Passes

Operating Practice

For some time the rolling mill has normally been in operation 16 hours daily and a total complement of 19 men is required for the two shifts. Each shift is made up as follows:

One head roller (day shift only)
One roller (night shift only)
One heater
One heater helper
One rougher }
One finisher } (on the furnace side of the mill)
One catcher }
Two helpers } (on the turning floor side)
Three laborers piling scrap (day shift only)

The roller, heater, rougher finisher and catcher are rated as blacksmiths while the head roller receives a differential. The others receive the regular rates for helpers and laborers.

It is worthy of note that the head roller, in direct charge of the operation of the mill, is an experienced rolling mill operator, and to this fact may be attributed, in no small measure, the successful development of the present practice.

The scrap material comes to the rolling mill from two sources. The greater part of the round stock comes from the scrap yard, where radial stays, staybolts and other rod and bolt scrap accumulates from all points on the system. The long pieces, such as radial stays, tie rods, etc., are sheared to 24-in., 30-in., and 36-in. lengths so that they may be used as foundations for the piles. The greater part of the flat and square bar scrap is made up of trimmings which accumulate in the blacksmith shop itself. This material is collected from various locations in the shop and the accumulation moved by crane to a point adjoining the rolling mill. Here the pieces are trimmed to conform to the lateral dimensions of the bundles and the bundles assembled.

The bundles are made in lengths of 24 in., 30 in., and 36 in., depending on the size of the stock to be rolled. All are 4½ in. square and each bundle is bound by two No. 8 iron wires. The composition of the bundles is clearly shown in one of the illustrations. The foundation is a layer of round material, sheared to length and laid on the two binding wires, which are bent to shape. The pile is then built up of miscellaneous flat and short round pieces and finished at the top with another layer of round material laid longitudinally. The piles average in weight about 94 to 100 lb. for the 24-in., 115 lb. for the 30-in., and 140 lb. for the 36-in. length. The 24-in. piles are used for rolling ⅝-in., ¾-in., and ⅞-in. stock and the 30-in. pile is used for 1-in. to 1½-in. stock. These two sizes take care of by far the greater part of the output, although the 14-in. rolling mill is capable of handling up to 2-in. finished stock. For bars over 1½ in. in diameter the 36-in. piles are used.

The mill is operating with an average furnace loss not exceeding eight per cent. The piled scrap, as it comes from the furnace, is run directly through the largest pass on the roughing rolls. For bundles of the size used extensive ragging is unnecessary; a few small radial grooves chipped in their sides prevent slipping in the first roughing passes. The material is worked down through the roughing passes until only a few passes through the finishing rolls are necessary. On the 1-in. material the bars go through nine roughing and four finishing passes. The welding up of the piles is completed in the first three or four passes.

The straightening bed adjoins the center bay of the shop, which is served by a traveling crane. As the finished bars cool they are piled just back of the straightening bed as shown in one of the illustrations. When a pile, such as that shown, accumulates, one end is lifted and swung under the traveling crane by the post gib crane shown in the upper foreground of the photograph. The pile is then moved to the shears, located just across the shop, where the bars are cut up into bolt lengths for the forging machine furnaces.

In the usual re-rolling mill practice, alternate oval and circular passes are used throughout the process. The passes on the Gothic roughing rolls, however, are all of similar form, with the longitudinal diagonal longer than the vertical and the bar as it comes from each pass is given a quarter turn about its axis before entering the next smaller pass in the rolls.

The rolling mill itself is in actual operation about one-half of the time. The remainder is taken up in recharging the heating chambers following each run of twelve bars. Under normal operating conditions each eight-hour shift produces from five to eight tons of finished bar stock, depending on the length of the bundles and the diameter of the finished bars.

The original finishing rolls are still in operation and there has never been a failure of any part of the mill. The only repair which so far has been required was the renewal of one bearing.

In addition to the average furnace loss of eight per cent, an additional two per cent is lost in defective bars and waste in cutting up to bolt lengths. This loss, however, has been found to be less than the normal cropage encountered in cutting up merchant bars because of the more economical use that can be made of bars running from 40 to 60 ft. in length than is possible with the merchant bar lengths.

The quality of the material is excellent. Assuming that proper care is exercised in heating, the working over of the bundled scrap adds to the refinement of the iron and the comparatively loose structure of the bundles causes a more complete working of the material in the center than would take place in solid billets of the same size. The finished bars are homogeneous in structure and show good fractures. Tensile tests indicate that the material averages the following physical properties:

Bundled Iron Scrap Ready for the Furnace

Tensile strength, lb. per sq. in.	50,152
Yield point, lb. per sq. in.	33,539
Elongation, per cent in 2 in.	27
Reduction of area, per cent	43

Average of 25 tests. Slight admixture of steel obtained from common iron reclaimed.

A comparatively small proportion of reworked material enters into the scrap, most of which consists of flat sections with an appreciable percentage of staybolts. An inspection of the make-up of the piled scrap as shown in one of the illustrations, remembering that the mill rolls only bolt stock, shows that there is no danger of a deterioration in the quality of the rolling mill output due to repeated reworking of the same material.

Re-Rolling Steel Scrap

Although probably 90 to 95 per cent of the output of the rolling mill is wrought iron stock, an occasional accumulation of material such as steel arch bars and coupler yokes is run through the mill. Only re-rolling operations are employed on steel, but here also the Gothic roughing rolls have demonstrated their value.

Instead of splitting rectangular sections, such as arch bars, it is possible to rough down the full size sections through the Gothic rolls, thus eliminating the shearing operations and half of the rolling operations.

Accounting

In arriving at the cost of operation of the mill, it bears a portion of all fixed charges against the department of which the rolling mill forms a part. The mill occupies approximately 5,000 sq. ft. of floor space and employs 19 men. Interest at 6 per cent is charged against the mill operation on a portion of the cost of the building, bearing the same ratio to the total as the ratio of the floor space occupied by the rolling mill to the total floor space in the blacksmith shop building.

Report of Beech Grove Rolling Mill Operation for the Month of October, 1920

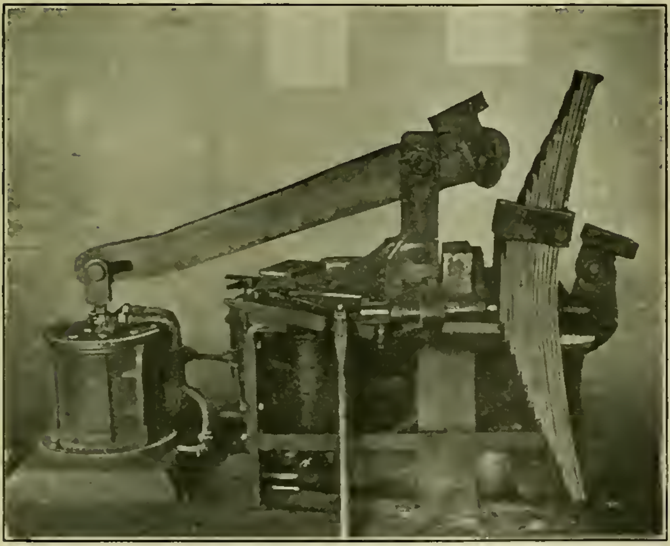
Scrap to furnace—		
370,720 lb. at $21.10 G. T.		$3,492.05
Fixed charges on mill and building for housing—		
Interest at 6 per cent rate per year	$168.71	
Depreciation	207.54	
Taxes at 1.8 per cent	47.45	
Insurance at .2 per cent	5.27	
Repairs at 3 per cent	83.33	
		512.30
Labor direct charge		2,655.66
398½ fuel hours at $1.86 per hour		741.21
398½ power hours at .30 per hour		209.55
26 days' supervision at $5 per day		130.00
		$7,740.77
Finished product—		
175,900 lb. ¾-in. rod iron at $3.35 cwt	$5,892.65	
118,940 lb. ⅞-in rod iron at $3.35 cwt	3,984.49	
50,300 lb. ⅝-in. rod iron at $3.40 cwt	1,710.20	
		11,587.34
Net profit for the month		$3,846.57
Net profit since April 11, 1918		36,225.87

In the same way a portion of the cost of the department's supervision is charged against the rolling mill operation bearing the same ratio to the total cost of supervision as the number of men employed in the rolling mill bears to the total number of men employed in the department. Interest at 6 per cent is also charged on the cost of the equipment and its installation and depreciation is charged at the rate of 5 per cent on the mill, 50 per cent on the furnace and 2 per cent on the floor space.

A statement showing the results of the operation of the mill for the month of October, 1920, is presented in the table.

Easily Made Spring Bander

For railway blacksmith shops handling a large amount of spring repair work, there is no question about the need for a modern, powerful spring banding machine. With sufficient springs to keep such a machine busy practically eight hours a day, enough time and money will be saved to pay a good return on the capital invested. For outlying points, however, where it is necessary to reband a spring occasionally for emergency work, some sort of inexpensive machine must be provided to perform the operation. The machine illustrated was designed for this purpose, using scrap air cylinders and reclaimed materials throughout, at a cost probably not exceeding $250.



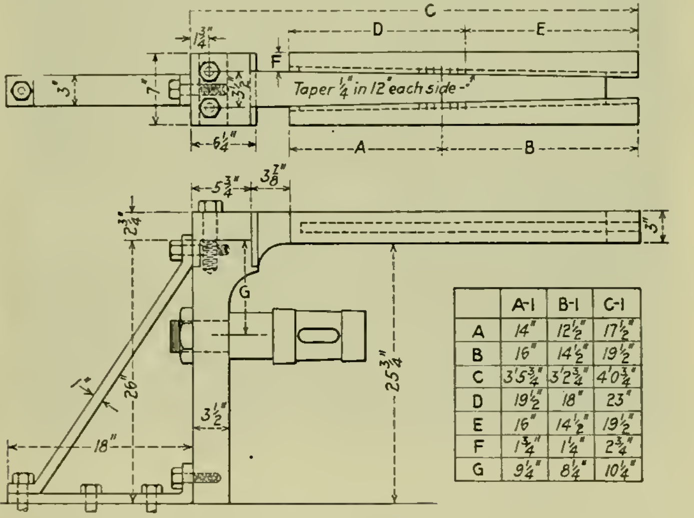
Spring Banding Machine Suitable for Small Shops

As shown in the illustration, the device consists of a substantial base plate mounted upon an iron frame work with the two operating levers moved by means of air cylinders. The ratio of the arms is such that with 80 lb. air pressure in the cylinders, ample power is provided to compress the spring band. While the strokes are not adjustable, it is possible by means of blocks of different thicknesses to accommodate a spring of any standard size.

In operation, the spring leaves are assembled in the correct order in a horizontal position on the table of the machine. The jack screw, illustrated, is used to press the leaves firmly together; then the spring is swiveled to a vertical position and the heated band slipped in place. After this operation the spring is swiveled back to the horizontal position, the movable jaws swung into place, and suitable blocks applied depending upon the spring size. Pressure is applied to the air cylinders and the heated band firmly pressed around the spring leaves in the usual manner.

Crosshead Babbitting Devices Eliminate Machining

It is a general practice to take up wear and maintain crosshead gibs to standard dimensions by babbitting. In most cases a mandrel of some nature is used and sufficient babbitt is poured into the gib to permit of machining it to the proper width and thickness. This involves two distinct operations and requires considerably more time than would be needed if just the right amount of babbitt could be put on in the first place and no machining was necessary. In order to save the time ordinarily required for machining, a large railroad system has developed the series of interesting and ingenious jigs and mandrels described in this article.



	A-1	B-1	C-1
A	14"	12½"	17½"
B	16"	14½"	19½"
C	3' 5¾"	3' 2¾"	4' 0¾"
D	19½"	18"	23"
E	16"	14½"	19½"
F	1¾"	1¼"	2¾"
G	9¼"	8¼"	10¼"

Fig. 1—Details of Fixture Used in Babbitting Alligator Crosshead Gibs

Alligator Type Crosshead

Details of the fixture used for babbitting alligator crosshead gibs are shown in Fig. 1 and the actual operation of pouring in Fig. 2. Referring to Fig. 1, the operation of the device will be practically self-evident. Three fixtures are provided for three types of alligator crossheads of various widths of guides and distances between guides. The three classes have been designated A-1, B-1 and C-1 for purposes of identification.

The crossheads are preheated by lowering them into the molten babbitt. On removal from the babbitt, they are cleaned of all surplus babbitt and dirt, being placed on the mandrel ready to pour one gib. The crosshead is not keyed on the mandrel, but is driven firmly in place. The guide width is cared for by setting the taper gibs of the jig, these gibs also having been preheated at the same time as the crosshead. Side play is equalized by using small wedges between the crosshead gib and guide mandrel, as shown near the ladle in Fig. 2.

That the finished wearing surface will be parallel with the guide is assured by measuring with a gage, hooking under the bottom crosshead gib and measuring to the under side of the jig. A special clamp with a hand screw is used for bringing the crosshead and jig into alinement, if necessary. A common C-clamp is used to hold the taper gib in place after adjustment. Graduations shown on the taper gibs are so spaced that movement of the gibs the distance represented by one graduation will vary the total width 1/32 in. It is thus an easy matter to adjust for any width of guide.

Repeated tests have demonstrated that accurate babbitting of alligator crosshead gibs is possible with these jigs. Crossheads have been checked by laying two straight edges along the two wearing surfaces and measuring in front of the crossheads at a distance equal to the stroke. The straight edges were found to be parallel to within 1/64 in. or less.

Box Guide Suspended Type Crosshead

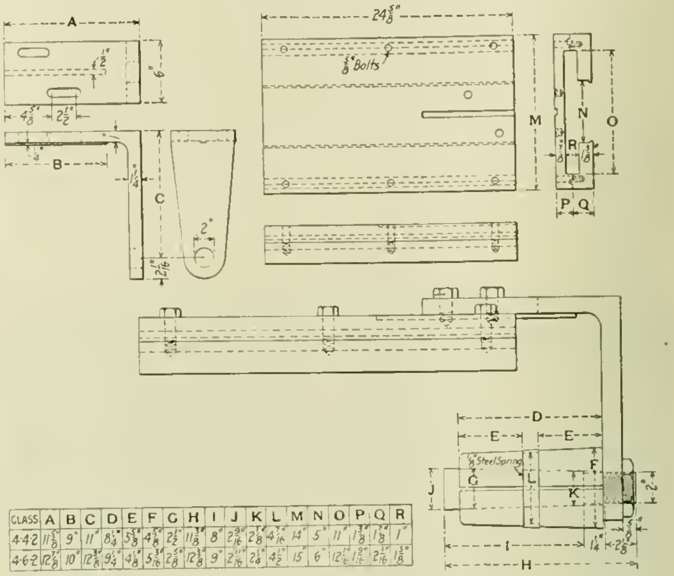
Arrangements for babbitting the four-guide, or box-guide, suspended type crosshead are made by means of the special jig illustrated in Fig. 3. In this case a somewhat more complicated problem is encountered since the crosshead must be removed in such a way as not to damage the babbitt. Consequently, the jig is made collapsible, and after the babbitt has been poured it is possible to remove the two lower plates illustrated and release the crosshead from the mandrel. The jig shown in Fig. 3 is adjustable and will accommodate two classes of crossheads as shown in the table. Longitudinal adjustment of the box can be made by loosening up two bolts, as shown, correct alinement being maintained by means of the tongue and groove arrangement indicated. Particular attention is called to the construction of the mandrel for holding the crosshead. It is made in three sections, being held on the taper pin by means of a 1 in. steel spring. The taper pin has one threaded end extending through the back plate and held by means of a 2 in. nut. Tightening this nut will, of course, expand the mandrel sections until they fit accurately and tightly the taper hole in the crosshead. It is possible by means of this jig to accurately aline a box guide suspended type crosshead and babbitt it so that no further machining is necessary.

Fig. 2—Pouring Babbitt in Alligator Crosshead Gib

Valve Stem Crosshead

To take up wear, valve stem crossheads also require babbitting and in most cases machining. A fixture designed to eliminate the necessity for this machining is illustrated in Fig. 4. As shown, the crosshead is supported on a mandrel, corresponding to the valve stem, securely bolted to the base plate. The sides of the base plate extend about half way up the sides of the crosshead, the other half being covered by means of the cover plate shown. The cover plate is held in accurate alinement by two 60 deg. shoulders as shown in the end view, Fig. 4. Two U-bolts, riveted in the base plate, extend through the cover plate and, in conjunction with two taper pins, provide for holding the cover plate firmly in place.

In operation, the fixture is up-ended with the crosshead in place and all small openings at the bottom are filled with clay. The babbitt is then poured. After cooling the cover plate is removed when the crosshead can be forced off by a taper key in the horizontal keyway shown.



CLASS	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
4-4-2	11 5/8"	9"	11"	8 1/4"	5 5/8"	4 5/8"	2 1/2"	11 3/8"	8"	2 9/16"	2 7/8"	4 7/16"	14"	5"	11"	1 3/8"	1 7/8"	1"
4-6-2	12 7/8"	10"	12 3/8"	9 1/4"	4 1/8"	5 3/16"	2 5/8"	12 1/8"	9"	2 11/16"	2 1/4"	4 1/2"	15"	6"	12 1/16"	1 9/16"	2 1/16"	1 3/8"

Fig. 3—Fixture for Babbitting Suspended Type Crossheads

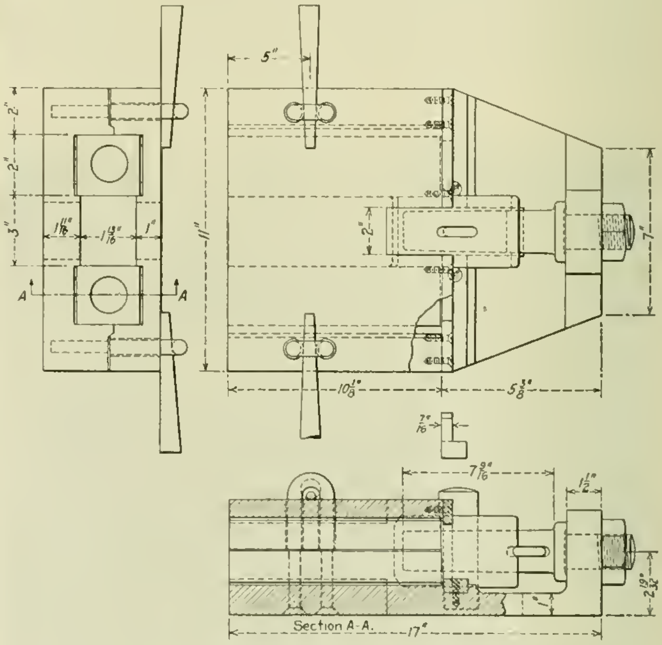


Fig. 4—Fixture for Babbitting Valve Stem Crossheads

Method for Squaring Walschaert Valve Gear

Changes Required in Various Parts May Be Determined by This Method with a Minimum of Time and Effort

BY W. J. DIXON
Assistant Master Mechanic, Baltimore & Ohio, Holloway, Ohio

BEFORE attempting to set the valves on a locomotive equipped with the Walschaert gear, a careful check should be made to determine whether such parts as the reach rod, tumbling shaft arms, radius rod hangers, union links, etc., are of the correct dimensions. After the above mentioned parts have been proved and the port openings correctly scribed on the valve stem, the engine should be run over, catching the dead centers in the usual way.

To determine the changes to make in the gear as based on the tram marks on the valve stem, an easy way is to proceed according to the following method:

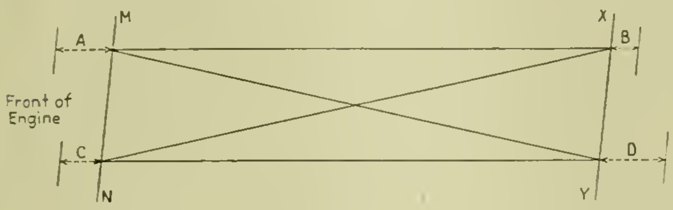


Fig. 1

Assume that lines *MN* and *XY*, in Fig. 1, represent the two port marks on the valve stem, and *A, B, C, D* are the tram measurements from the port marks:

Rule I:

$(A + C) - (B + D)$ divided by 4 = valve rod change.

Rule II:

$(A + D) - (B + C)$ divided by 4 = eccentric rod change, *at valve stem.*

Rule III:

$(A + B) - (C + D)$ divided by 4 = crank arm change, *at valve stem.*

In making the above computations it is understood the lesser is subtracted from the greater which might reverse the above combination. For example, to compute the valve rod change we might have $(B + D) - (A + C)$, etc.

Fig. 2

Fig. 3

Example 1

Taking a practical example, assume the diagram shown in Fig. 2 represents the valve stem reading. The numbers indicate the measurements from port marks in thirty-seconds of an inch. The forward motion is shown below, while the back motion appears above the center line, the front of the engine being at the left.

To obtain the valve rod changes using Rule I:

$$(4 + 24) - (8 + 12) = 8$$
8 divided by 4 = 2, or 1/16 in.

Therefore, the valve rod should be shortened 2/32 or 1/16 in., as there is a direct motion on this part. Making this change gives the valve stem reading as shown in Fig. 3.

Proving the above operations gives the following results:

$$(10 + 14) - (2 + 22) = 0$$

The next step is to determine the required change in the eccentric rod. Taking conditions after the valve rod alterations have been made as indicated in Fig. 3. and using Rule II:

$$(10 + 22) - (2 + 14) = 16$$
16 divided by 4 = 4, or 1/8 in.

From Fig. 3 it can be seen that the valve should move back 4/32 in. Referring to Fig. 1, this change would take 4/32 from *A* and *D* and at the same time add four each to *C* and *B*. This would produce readings on the valve stem as shown in Fig. 4. To prove the correctness of the operations we have:

$$(6 + 18) - (6 + 18) = 0$$

This shows that no further change is necessary for a balance of figures either for valve rod or eccentric rod. However, the change shown above is a result obtained at the valve stem. To bring about the change, it is necessary to make a greater alteration in the eccentric rod. This is determined by multiplying the valve stem change by a factor determined by dividing the travel of the valve in full gear into the throw of the eccentric arm. For example, if the travel of the valve is 6 in. and the throw of the eccentric arm is 18 in., 18 divided by 6 = 3. Referring to the 4/32 in. used in Fig. 4, 4 multiplied by 3 = 12, or 3/8 in., the amount which the eccentric rod should be shortened to obtain the results shown in Fig. 4. In determining whether to lengthen or shorten the eccentric rod it should be borne in mind that when the link block is located at the bottom of the link, a direct motion exists from the eccentric crank arm pin to the valve itself. Therefore, lengthening the eccentric rod adds to *D* and *A* (Fig. 1), while *B* and *C* are diminished an equal amount. Shortening the rod has an opposite effect throughout.

Fig. 4

Fig. 5

Referring to Fig. 4, it will be noted that having made alterations to the valve and eccentric rods, the valve is square in both forward and back motions, but has more lead in the forward motion. To correct this proceed as follows, applying Rule III:

$$(18 + 18) - (6 + 6) = 24$$
24 divided by 4 = 6

A 3/16-in. change in lead is needed at the valve stem. This would require a crank arm change on the main pin sufficient to give 3/16 in. more lead in the back motion. In doing this, 3/16 in. lead would automatically be taken from the forward motion, producing the results shown in Fig. 5.

Example II

Should the tram marks on the valve stem measure up as shown in Fig. 6, it is necessary to proceed as follows, using

Rule I to obtain the valve rod change:

(8 + 16) — (24—4) = (8 + 16 + 4) — 24 = 4
4 divided by 4 = 1

Therefore the valve rod should be lengthened 1/32 in.

This alteration gives the diagram shown in Fig. 7. It should be borne in mind that when a tram mark on the valve stem shows blind, the measurement is negative and should be so considered when computing the change.

The eccentric rod change to correct Fig. 7 is made by applying Rule II as follows:

(7 + 25) — (15 — 3) = (7 + 25 + 3) — 15 = 20
20 divided by 4 = 5, or 5/32 in.

The eccentric rod should therefore be shortened to produce 5/32 in. change on the valve stem. Making this change gives results as shown in Fig. 8.

To find the necessary change in the lead and the movement of the crank arm position correcting Fig. 8, Rule III is applied as follows:

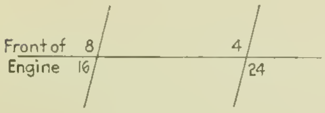


Fig. 6

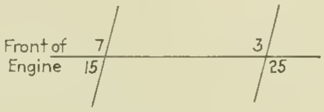


Fig. 7

(20 + 20) — (2 + 2) = 36
36 divided by 4 = 9, or 9/32 in.

The crank arm should be moved back on the main pin to produce the above change of 9/32 in. on the valve stem. Making this change produces results as shown in Fig. 9.

Referring to Figs. 5 and 9, it is seen that the valve has been squared with equal distributions in forward and back motions. By the above outlined method, it is possible to prove each operation so that the mechanic may always be sure that he is making correct changes. The three changes may be made in any order: for instance, the eccentric or crank arm alterations may be given consideration first if desired.

Fig. 8

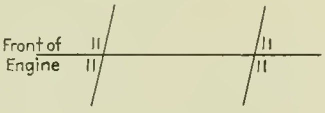


Fig. 9

In closing it may be well to call attention again to the first paragraph of this article. In order to obtain satisfactory results, the parts mentioned must be to all practical purposes perfect. Otherwise it might be possible to obtain correct readings on each valve stem separately and yet not have square valves on the locomotive.

The method of squaring valves explained above is also applicable to the Baker valve gear. It should be borne in mind that the factor used to determine the eccentric rod change always is a constant of four regardless of the valve travel and throw of the eccentric arm.

A Large Plant installed an electrical thermometer system to detect any increase in temperature in its coal pile, the pyrometer being in the engineer's office. Machinery further says:

"A temperature of 250 deg. F. was considered the safe internal temperature. Portable receptacles for thermo-couples were constructed of one-inch wrought iron pipe, welded to a point at the end entering the coal pile, and the exposed end was fitted with a self-closing cap. The switches in the engineer's office were numbered and lettered to correspond with these receptacles. The engineer was thus enabled to observe the temperature readings of the coal at the different points, and to detect dangerous increases of temperature."

The Effect of Relative Humidity on Leather Belting*

By F. W. Roys,
Worcester Polytechnic Institute

Any one who has ever had anything to do with leather belting knows that an ordinary oak tanned leather belt, not waterproofed or weather proofed, changes its characteristics considerably with the weather conditions, and it was because no information was available regarding these effects that experiments were undertaken, the conclusions from which are quoted.

All of the experiments were made on a single specimen of belting, and it will not be contended that the results are applicable, directly, to any other belt. However, it is assumed that if consistent results have been obtained for this particular sample, other belts of the same sort of material will show similar characteristics, the same in kind, if not in amount.

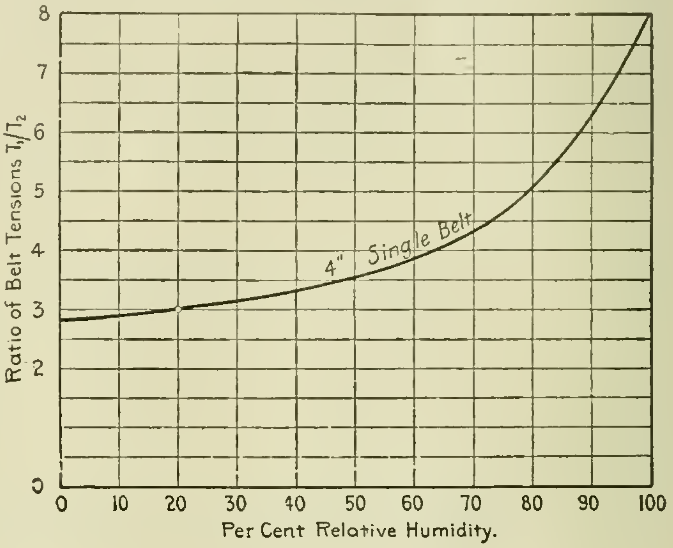


Fig. 1—Effect of Increasing Humidity; Horse Power Constant

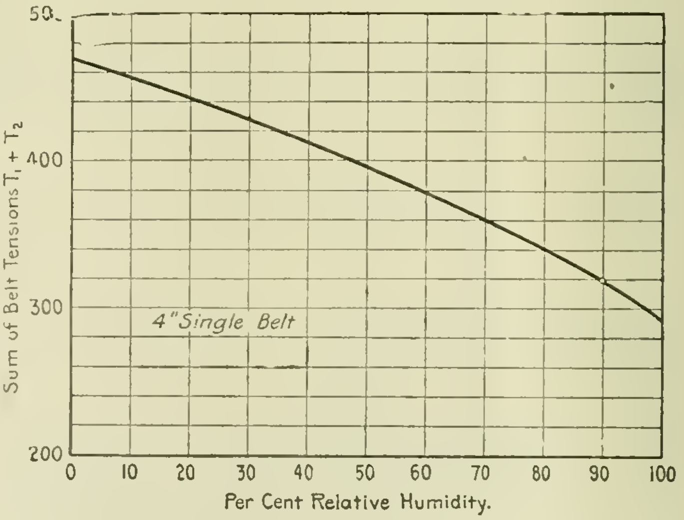


Fig. 2—Effect of Decreasing Humidity; Horse Power Constant

In a general way it may be stated that the effect of a change in the relative humidity is greater at high humidities than at low; that the effect is shown more rapidly in single

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*From a paper read before the National Association of Leather Belting Manufacturers, November 17th, 1920.

than in double belts; that an increase in the humidity shows practically immediate results, while a decrease in the humidity takes a longer time to be effective.

Much more attention should be paid to the effect of the relative humidity than is ordinarily the case. Suppose that a plant engineer who is supposed to see that belts are kept tight and working at the proper tensions, pays no attention to the weather conditions, but has the belt tightened to a tension which he calls standard.

If such an adjustment was made when the relative humidity was 20 per cent and a subsequent change in the weather conditions produced a relative humidity of 90 per cent, while the power to be transmitted remained the same, the sum of the belt tensions $T_1 + T_2$ must decrease. Since the difference in tensions remains the same while the sum decreases, it is evident that the ratio T_1/T_2 must increase. Fig. 1 shows this variation quite clearly, and at the higher humidities this ratio reaches a value where the belt is in great danger of slipping.

On the other hand, suppose that the belt was set to standard conditions when the relative humidity was 90 per cent and subsequently the atmosphere dried. The belt would then become far too tight, not only working at too high a stress, but also producing excessive pressure on the bearings. Fig. 2 shows this effect very clearly.

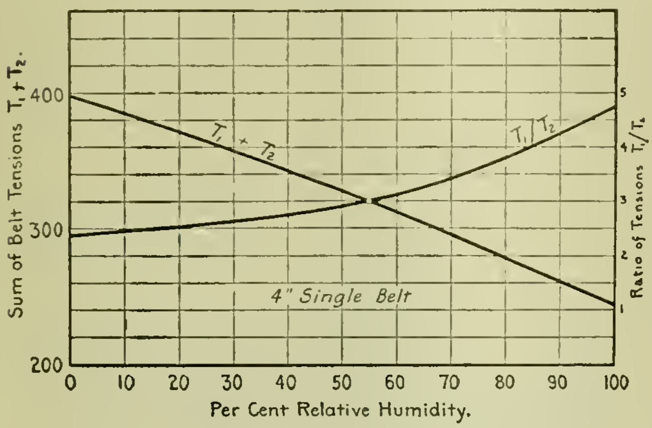


Fig. 3—Effect of Change of Humidity from 55 Per Cent; Horse Power Constant

If care were taken to allow for the effect of a change of the relative humidity, or if the adjustment were made when the humidity was 55 per cent, then no change of humidity that would occur would either tighten or slacken the belt in a degree that would be likely to give any trouble. Fig. 3 shows the effect on both the ratio and the sum of the tensions.

All of the preceding tests were made at a temperature of 70 deg. F., and it should be noted that the higher humidities are apt to occur at temperatures above 70 deg. F. and the lower humidities below 70 deg. F.

In conclusion, it may be stated that if a belt drive can be fitted with a spring or gravity tightener, so called, a load probably 50 per cent greater can be carried without danger of stretching the belt, slipping or excessive pressure on the bearings.

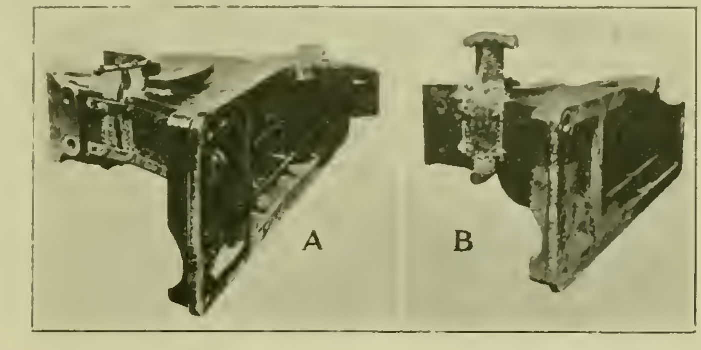
Casting Locomotive Frames in Small Units.—In order to overcome the difficulties of casting locomotive frames of unusual length and other long sections, the Metal & Thermit Corporation, New York, recommends that these be cast in shorter units and these units thermit welded together. By using this method small foundries can undertake the work. The number of parts to be welded will depend on the size of the foundry and available mold and pattern facilities.

An Air Compressor Repair

The connecting-rod of an air compressor, one of two units operated at the Erie Railroad shops, Susquehanna, Pa., for supplying air pressure to the pneumatic tools, recently snapped in two, causing one end of the rod to fly around into a wedged position and exerting such a strain on the machine that the hollow cast-iron back frame of the bed plate broke off.

The cross section of the hollow casting at the point of fracture measured about 8 in. by 6 in., the thickness of two opposite walls being 3 in. and the other two opposite walls only ⅞ in.

A new bed plate was ordered, but it was impossible to get it delivered in less than 60 days. As the idleness of this air compressor cut down the compressed air supply over all the shops 50 per cent, the operators decided to make a Thermit weld. In welding the casting, the bed plate was laid on its side and the broken sections were lined up by means of bolted straps, as shown at *A* in the illustration. These straps were left on and welded in with the metal comprising the weld. Three hundred pounds of cast-iron Thermit were used and the welded bed plate was returned to service. The appearance of the plate immediately after welding is shown at *B*.



Air Compressor Bed Plate Before and After Welding

Locomotive Cylinder Welding*

One of the most costly repair jobs on locomotives is replacing broken cylinders. A locomotive cylinder is a complicated core casting, weighing two or three tons, which requires careful fitting to the boiler, frame and opposing cylinder to insure alinement. If so badly cracked by any cause that replacement is required, the job involves not only a new cylinder but fitting in place, which work may keep the locomotive out of use for several weeks. Thus, the loss of service in a busy period may be a greater item than the actual cost of the new cylinder and the labor. Hence the importance of a process which enables a broken cylinder to be restored to service in the shortest possible time. This the railway shops have in oxy-acetylene welding.

A common cause of cylinder fracture is carelessness in closing the cylinder cocks and trapping water between the piston and the head. A slug of water is practically incompressible and when caught between the advancing piston and the head something must give way. Often the cylinder head is broken into fragments and the flanges ripped off. Breaking piston rods also wreck cylinders frequently. Another cause less frequent, but from which many locomotives suffer in cold weather, is freezing of water in the cylinders which crack by the expansion of the ice or are fractured when the attempt is made to move the locomotive. Head-on collisions add their quota of cylinder repair work.

The secrets of successful cylinder repair with the oxy-acetylene torch are proper preparation, preheating and slow

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*Abstracted from the January, 1921, issue of Autogenous Welding.

cooling. There seems to be almost no limit to what can be done in restoring broken parts if care is taken to preheat to redness and to cool slowly when the job is finished. Even if the fracture is one that requires the cylinder to be removed in order to work the molten metal in a level position the saving is still substantial as the time needed for the welding and replacement is much less than that required to supply a new cylinder and to fit it in place.

In the course of cylinder welding, James Causey, cylinder repairman at the Wabash shops, Decatur, Ill., has developed a method of preheating which is a departure from the methods commonly used. Mr. Causey formerly followed the practice of building a firebrick wall around the cylinder to be welded, but in succeeding jobs such parts of the wall as could be dispensed with were removed. The result is, that at the present, no firebrick whatever is used for heat retaining. Asbestos paper extending entirely around the side walls or above the cylinder is employed instead. A large wire basket is placed below the cylinder to hold charcoal, and to the end of each cylinder, extending half way up, is bolted a thin plate to act as a retaining wall for the charcoal within the cylinder. The charcoal in the basket and cylinder are fired and more is added from time to time as it burns away until the desired degree of preheating is obtained. Then the cylinder plates are removed and the burning fuel hoed out. After the welds are made the plates are replaced and the charcoal is also added in quantities sufficient to retain the heat in the cylinder.

Driving Box Grooving Device

Grease grooves in driving boxes are ordinarily cored or chipped but there are disadvantages to either of these methods. Cored grooves may sometimes contain foreign matter which will cut the journal and, if not, the grooves may be greatly reduced in size or entirely eliminated due to wear and reboring of the boxes. Chipping, on the other hand, is an operation which requires considerable time and gives more or less unsatisfactory grooves due to irregularity and lack of sufficient depth.

A device for milling oil grooves in driving box crown bearings has been developed and used with considerable success for this work. A general view of the device is shown in Fig. 1, and details of construction in Fig. 2. Referring to Fig. 2, the device consists of a base plate *B* into which is firmly fastened the hollow vertical post *C* which has two large portions of its cylindrical surface cut away as shown. The moving part of the fixture consists of a right angle gear driving an end mill and guided by means of master plate *D* and control pin *E*.

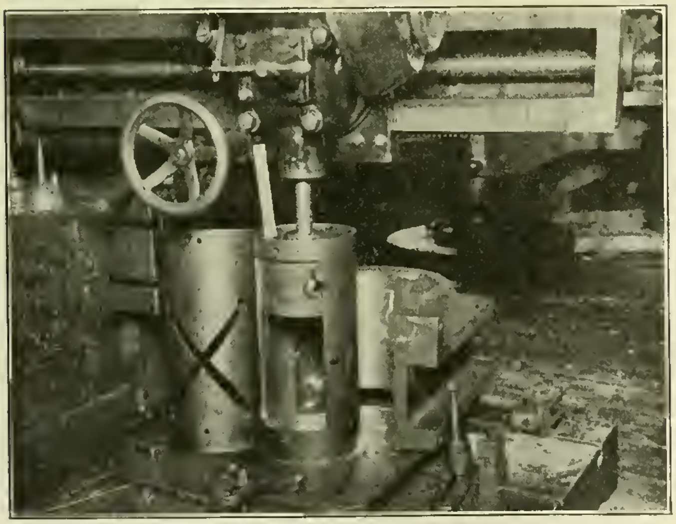


Fig. 1—Grooving Device with Master Plate Removed

In operation, the mechanism is clamped to the base of a radial drill which furnishes power to revolve the end mill *M* through the arbor *F*, bevel gears *G* and *H* and shaft *N*. Pinion *I* and gear *J*, arranged to mesh with rack *K*, control the feed of the tool in to the required depth. It is held at that depth by a ratchet arrangement on flange *L* (not shown). Since the end mill is guided entirely by the master plate, it is evident that grease grooves in any desired size of driving box can be milled by providing the necessary master plate. In setting up, the driving box is slid onto the base plate and clamped so that the axis of the grooving device coincides with the center of bore of the box.

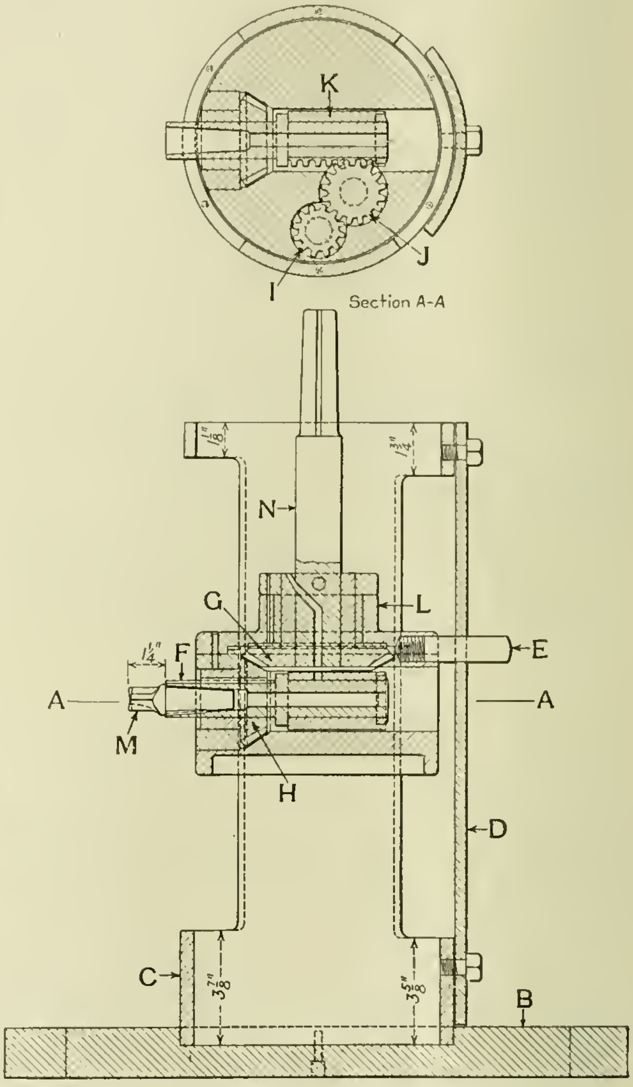
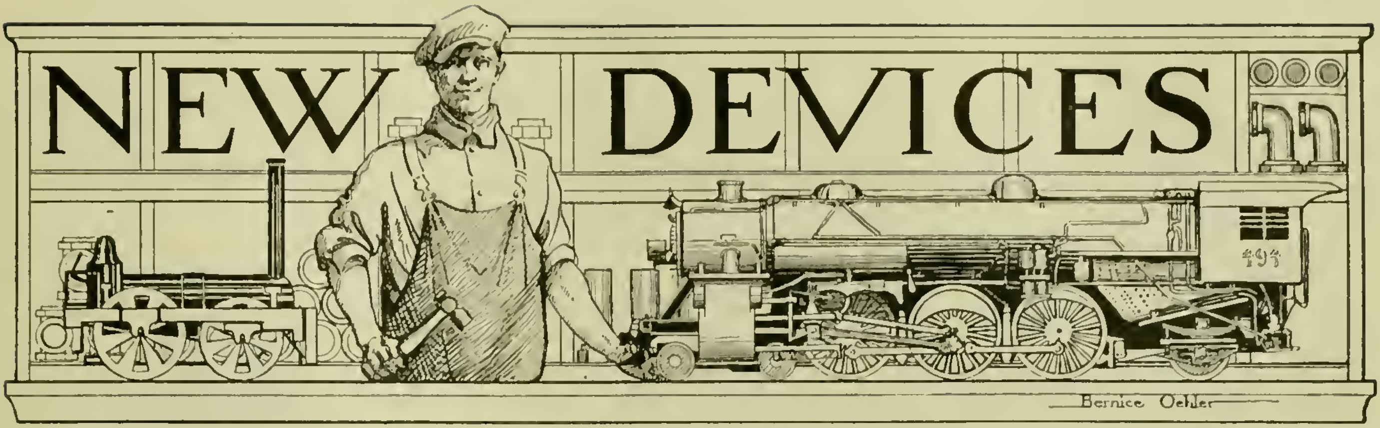


Fig. 2—Details of Driving Box Grooving Device

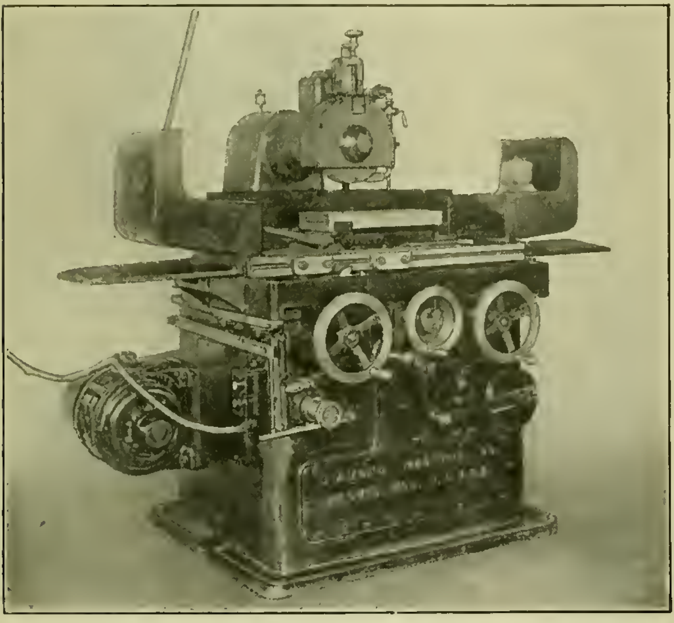
To summarize briefly, the device consists of a right angle gear box driving an end mill and guided by a master plate while the spindle of the drill is fed down. Starting at the top of the slot, the end mill is fed down, care being taken to guide it over the crossing of the slots. Then returning to the center, it is fed up and down to complete the diagonal slots.

The Allegation that railroad managers sent engines and cars for repair to outside shops in order to put "honest graft" into pockets of personal friends is proved by facts and figures to be totally false. If railway shop employees would do more work they would get more work.—*Forbes Magazine* (N. Y.)



Small High Duty Surface Grinder

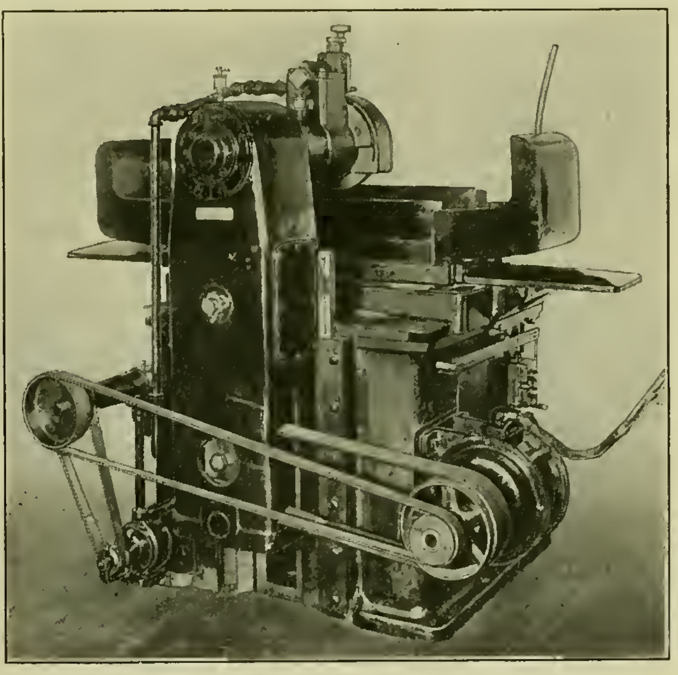
RIGIDITY of construction and ability to remove metal quickly are features of the new Type C surface grinder, made by the Diamond Machine Company, Providence, R. I. Work 10 in. wide, 24 in. long and 8 in. high can be ground. One of the unusual features of this grinder is the casting of the wheel spindle head integral with the vertical column. The combined column and head rather than the head alone is adjusted up and down for different thicknesses of work. The mass of this large column added to that of the head itself is responsible for much of the improvement in the quality of the work produced.


Diamond Type C High Duty Surface Grinder

Another feature closely connected with the above is the construction of the main spindle bearing nearer the grinding wheel. This is a composite ball and plain bearing which combines the advantages of both types without the defects of either. The rear end of the spindle is also provided with a ball bearing. The driving pulley is between the two spindle bearings and nearer the rear bearing so that any vibration of the driving belt cannot produce corresponding vibrations in the spindle itself. Moreover, the spindle between bearings is 2¼ in. in diameter so that flexure vibrations are avoided entirely.

The hand wheels for the three adjustments are arranged side by side at the top and front of the base and are placed symmetrically with reference to the center line of the machine. The left hand wheel for longitudinal travel moves the table about 2 in. per rev.; the center wheel moves the table transversely (in or out) .500 in. per rev., and the right hand wheel raises or lowers the wheel head (with column) .100 in. per rev. The outer edges of the rims of the two latter wheels have graduations for each thousandth of an inch so widely spaced that the operator can readily split the thousandths into tenths. Ball thrust bearings are used on both the horizontal and vertical adjusting screws. Careful arrangements of piping, guards and troughs assure an ample supply of coolant which stays where needed and does not spatter over the machine and floor.

The ways for all three directions of travel are completely covered by metal guards to prevent injury from abrasive dust or gritty water. Longitudinal travel of the table is accomplished by a train of belt driven gears and reversal is effected by a single shifting belt. A simple though novel device insures a complete shifting of the belt at each end of the stroke. A "stop trigger" is provided and a momentary pressure of the finger upon this trigger will stop the table at the completion of any stroke already begun. A clutch connected


Rear View of Grinder Showing Drive Arrangement

with the left hand wheel will stop the table instantly at intermediate points.

The transverse of "in and out" table feed is automatic and adjustable from .001 in. to .020 in. The feed takes place at both ends of the table travel and can be adjusted to move in either direction. There is an automatic stop for this feed which prevents overtravel and can be set to disengage at any desired point.

With the Type C grinder, the usual sliding toothed clutch for reversing has been eliminated which makes possible heavier cuts. A cut .234 in. deep and 1/16 in. wide, or a total cross section of .0150 sq. in., has been taken. It is stated that a pound of metal per minute can be removed with this machine. This high rate of cutting makes this grinder well adapted for production work on parts up to the maximum size that can be handled.

Regulating Valve for Liquid Fuels

THERE are many types of liquid fuels and each type is found in an almost indefinite number of grades, nor do these various grades run absolutely uniform. It is, therefore, necessary to use some sort of regulating valve which will compensate for the wide difference in liquid fuels and deliver to the burner a constant flow of fuel of varying viscosity and only in sufficient quantity to secure complete combustion. A valve designed for this purpose and known as the Rigby liquid fuel regulating valve has been placed on the market recently by Baily-Lewis, Inc., Pittsburgh, Pa. This valve has been tested and used with good success during the last two years at the Farrell Works of the Carnegie Steel Company.

As shown by the cross-sectional view, the fuel enters at the opening *12* and passes down through the stop-cock *3* into the trap *8*, where any sediment or heavy particles of fuel settle. The fuel then passes easily through the triangular opening in the valve seat *21* to the nozzle or burner.

The vital feature of the valve is the triangular aperture in the valve seat beveled back from the face and the sliding, shearing valve running in a groove cut in the face of the seat. A top view of the valve seat and triangular opening and a sectional view through the valve seat *20*, triangular opening *21* and valve are included in the illustration *4*. From these the manner in which the valve slides across the triangular opening, 1 in. long by ⅛ in. at its greatest width, will be apparent. This movement regulates the flow by opening and closing the aperture.

The area of a ⅛-in. orifice is .0123 sq. in., being approximately equivalent to a ½-in. needle valve open just 1/100 in. The impossibility of passing liquid fuel through a 1/100-in. opening is apparent. The superiority of the Rigby valve is due to the triangular shaped opening in the valve seat. This shaped orifice can have an opening of ½ in. against a 1/100-in. opening on a needle valve to give the same approximate orifice area, as shown in the table. Moreover, a needle valve has a wide seat which allows sediment or particles passing through the valve to impinge on the seat, thereby completely clogging the valve. The Rigby valve has its smallest aperture at the seat where the fuel enters the triangular opening and is beveled off as shown at *30*, so that when fuel passes through the aperture it must pass into the outlet for burning; it cannot stop as the beveled opening gives no opportunity for impingement.

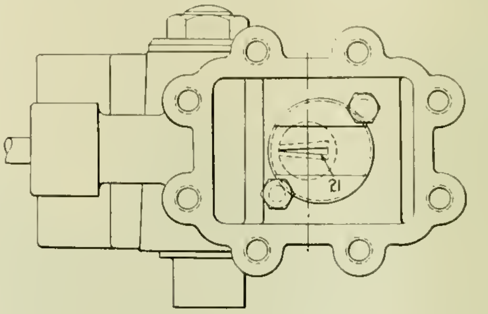
TABLE OF AREAS OF RIGBY VALVE OPENINGS

Travel of Valve	Area
⅛-in.	.00097 sq. in.
¼-in.	.0039 sq. in.
⅜-in.	.0087 sq. in.
½-in.	.0156 sq. in.
⅝-in.	.0243 sq. in.
¾-in.	.0351 sq. in.
⅞-in.	.0477 sq. in.
1-in.	.0625 sq. in.

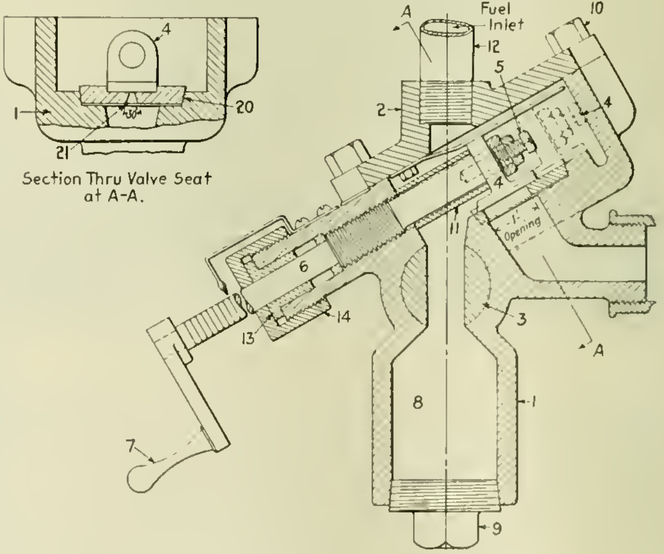
If sediment should lodge in the opening on the seat, it can be cleaned off by turning the handle of the valve *7*, thus closing the valve. The stem of the valve is threaded so that one complete turn of the handle moves the valve 1/16 in. This operation immediately shears off the particle of sediment and pushes that part above the seat into trap *8*, the balance of the particle immediately passing through the triangular opening when the valve is again opened. This operation can be accomplished in a few seconds and the valve can be reset to give the same opening.

The trap *8* can be cleaned in a few minutes without stopping the flow of fuel through the valve, by turning stop-cock *3* and removing the plug *9*.

The lock-nut arrangement makes it possible to set the valve for any required quantity of fuel necessary. It also provides a guarantee against waste of fuel. The installation of the valve from a safety point of view is highly important, as explosions due to leakage are almost an impossibility. It is stated that savings of five to 15 per cent are possible by using the Rigby regulating valve. The valve is manufactured in sizes suitable for various conditions, with two standard sizes; namely: type "A" with 1-in. valve travel; and type "B" with ½-in. travel.



Top View with Lid and Valve Removed.

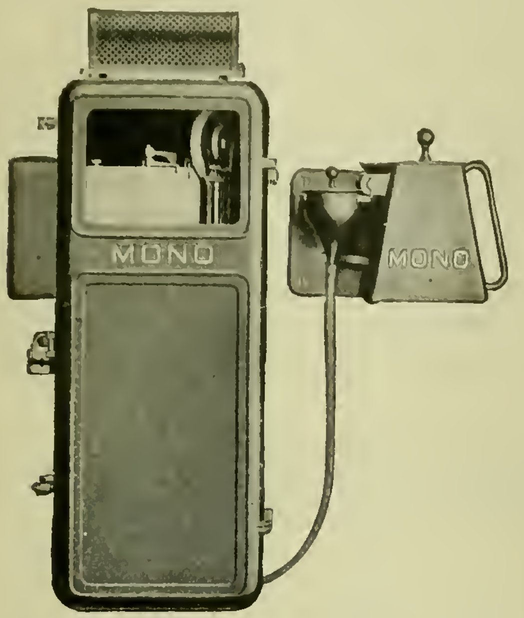


Section Thru Valve Seat at A-A.

Details of Rigby Liquid Fuel Regulating Valve

Duplex Mono Flue Gas Analyzer

A new type of instrument designed to make automatic analyses of flue gases and to record both CO_2 and combustible gases has been developed by the Mono Corporation of America, Buffalo, N. Y. The instrument, which is known as the Duplex Mono Gas Analyzer, is intended to give a more reliable indication of the efficiency of combustion than can be obtained by the use of an instrument recording CO_2 alone. To show the necessity for greater refinement in flue gas analysis, it is pointed out that an increase of one per cent in the combustible gases may decrease the efficiency of combustion over six per cent. The percentage of CO_2 at which combustible gases begin to form, varies considerably from time to time, even in the same furnace. Occasional tests with hand instruments to determine the presence of CO do not give sufficient data to insure proper combustion conditions, and effective combustion control can be established only by continuously recording the percentage of CO_2 as an indicator of the amount of excess air present and also detecting and recording the presence of combustible gases, either CO, CH_4 or H_2.



Automatic Analyzer for Recording CO_2 and Combustible Gases

The Duplex Mono is designed to detect the presence of combustible gases in the flues immediately upon their appearance and to record accurately the percentage of CO_2 at that particular time. The chart shown herewith is a diagram made by one of these double recording instruments. The lower contour of the diagram represents the percentages of CO_2 present at all times. The lighter areas indicate the presence of combustible gases. The height of the lighter areas indicates roughly the proportion of combustible gases present, but is not intended as a measure of the actual percentage and is on a larger scale than the CO_2 record.

The apparatus which is shown in the illustration is driven by water pressure of about 10 lb. per sq. in. Before entering the instrument, the gas samples from the flue are pulled through a filtering system, which removes all soot and dirt. They are then drawn into and forced through the apparatus by a mercury piston. There are no mechanical valves, such functions as these ordinarily fulfil being performed by various kinds of mercury seals, traps and similar arrangements.

Samples of gas are forced alternately through two routes, one leading directly through a caustic potash tank where CO_2 is absorbed, and the other first through an electrically heated furnace wherein the combustible gases are oxidized to CO_2 and H_2O, and then through the caustic potash tank. Samples that are forced through the caustic potash tank only give the readings for CO_2. Those that are first forced through the electrically heated furnace and then through the caustic potash tank give readings of CO_2 plus combustible gases. The difference between any two successive readings is proportional to the amount of the combustible gases present at the time the analyses are made.

In the electrically heated furnace, the oxygen necessary to oxidize the combustible gases, CO, CH_4, and H_2 to form CO_2 (which is later absorbed in the caustic potash tank) and water (which is condensed) is usually taken from the air which is almost invariably present in flue gases, even when combustible gases are present. When such free oxygen is not available, oxygen is taken from copper oxide provided in the furnace for that purpose. The copper oxide, however, probably seldom acts as anything but a catalytic agent and need never be renewed.

Should any of the copper oxide be reduced to plain copper to oxidize combustible gases in the process of analysis, it is reoxidized by oxygen present in the flue gas samples passing through the electric furnace later.

To diminish the lag between the time when the gas leaves the flue and the analysis is recorded on the chart, small communicating tubes are used. The lag between the time that the sample is taken from the flue to the time that it is recorded by the instrument is about three minutes where the distance between the instrument and the point where the flue is tapped is about 60 ft. and the instrument is making about 40 analyses per hour.

These instruments are made to produce records covering a range of either 20, 25 or 40 per cent, according to the purpose for which they are intended. The apparatus is practically dustproof and requires only a slight amount of attention, which consists in winding the clock once a week, replacing the caustic potash solution two or three times a month, replenishing the ink supply twice a month, and putting in new rolls of recording paper once every two months.

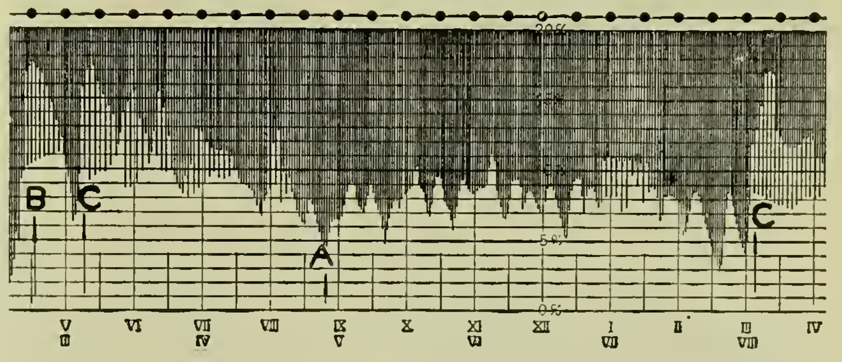


Chart from Duplex Mono Analyzer Indicating Presence of Combustible Gases

The readings indicating the presence of combustible gases are exaggerated, if anything, by the Duplex Mono. This is quite an advantage in a danger signal. The losses due to the appearance of combustible gases are much greater than the savings due to an equivalent increase in CO_2 as registered on the chart, and an exaggerated record of their presence on the chart has a favorable effect on the fireman. Since it is aimed never to have combustible gases present at any time, there would be no object in having exact records of the percentage present when they do appear. An approximate, and preferably an exaggerated record, as made by this instrument, is all that is necessary. The CO_2 records of the machine are invariably accurate.

The utmost efficiency of combustion is attained with the highest percentage of CO_2 that can be reached in a given furnace without having combustible gases begin to appear. The higher it can be raised, the more economical is the process of combustion. Knowing its maximum from the records of the instrument, the fireman can always tell the degree to which he is approaching ideal conditions. Should combustible gases appear at a point below the critical point, he knows that his dampers, fire doors, or the fire itself needs immediate attention, which experience soon teaches him to give to the best advantage. The record is equally valuable for the plant executive.

Safety Locomotive Cold Water Sprinkler

ONE positive advantage and three negative advantages are claimed for the locomotive cold water sprinkler, recently invented by George Dittman, roundhouse foreman of the Pittsburgh & Lake Erie, at McKee's Rocks, and placed on the market by the McKee Company, Pittsburgh, Pa. An abundant supply of water at a usable temperature is provided and the device will not discharge steam or hot water, cannot freeze and will not interfere with any other device on the locomotive.

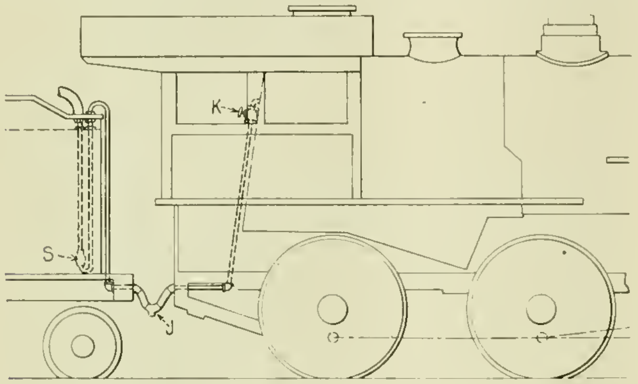


Fig. 1—General Arrangement of Dittman Cold Water Sprinkler

The general arrangement of the sprinkler on a locomotive and tender is shown in Fig. 1, which indicates the ease of applying or removing it without draining the tank. Referring to Fig. 1, *K* is the steam control valve, *J* the automatic drain fittings and *S* the sprinkler valve proper. Valve *S* is shown more in detail at *A*, Fig. 2. When the operating valve is open, steam passes through the piping to the underside of the sprinkler valve, expanding through the nozzle and drawing water through the small holes indicated. Part of the velocity of the steam is imparted to the water which is delivered in a continuous stream to the sprinkler hose. The location of the valve in the bottom of the tank assures an ample supply of cold water and eliminates danger of discharging steam or hot water and scalding the fireman.

The automatic bronze drain valve shown at *B*, Fig. 2, is placed at the lowest point in the steam supply pipe or hose and, as shown in the illustration, remains open except when steam pressure is applied, thus preventing freezing.

The application of the Dittman cold water sprinkler is easily made. A hole 1¾ in. by 3½ in. is cut in the top of the tank at a convenient point; two ⅝ in. bolt holes, spaced 5 in. on centers, being drilled to receive the studs. Referring to *A*, Fig. 2, a return bend is made in a piece of ⅜ in. pipe long enough to reach to the bottom of the tank. The sprinkler valve and cover plate are applied as shown with the return bend secured to the cover plate by lock nuts at the top and bottom. Application of the studs holds the device firmly in place. The installation is completed by applying a steam valve *K* at a convenient point on the back head and inserting the drain valve at the lowest point in the connecting piping.

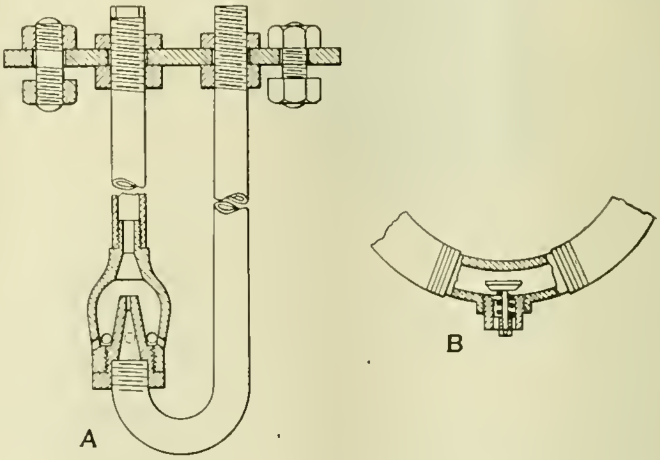
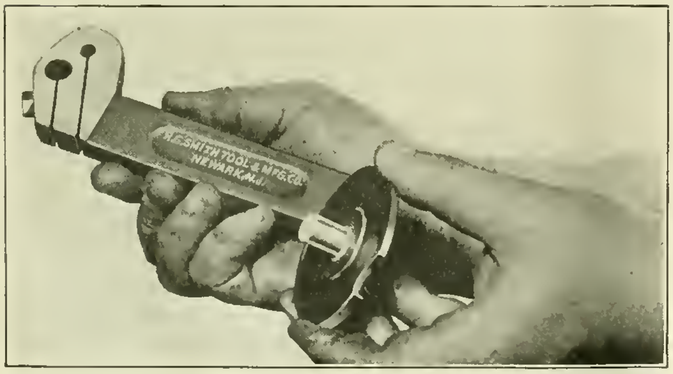


Fig. 2—Details of Sprinkler and Drain Valve

A Long Life Cutting-Off Tool



Cutting-Off Tool With Long Cutting Circumference

A NOVEL cutting-off tool with a cutting circumference of over 300 deg. has been developed by the R. G. Smith Tool and Manufacturing Company, Newark, N. J. This cutting-off tool, as shown in the illustration, is made so that clearance is maintained throughout the entire cutting circumference by gradually tapering down the thickness of the cutting edge. This gives the tool ample side clearance rake, the other clearance being secured by grinding when sharpening.

This tool is used in the patented Smith tool holder, being held firmly in place by tightening up the set screw shown with a small hexagonal wrench. On account of the ease of sharpening and long life of this cutting-off tool, it is adaptable to use in automatic screw machines and turret lathes, as well as in hand lathes.

Centrifugal Pump for Cooling Compounds

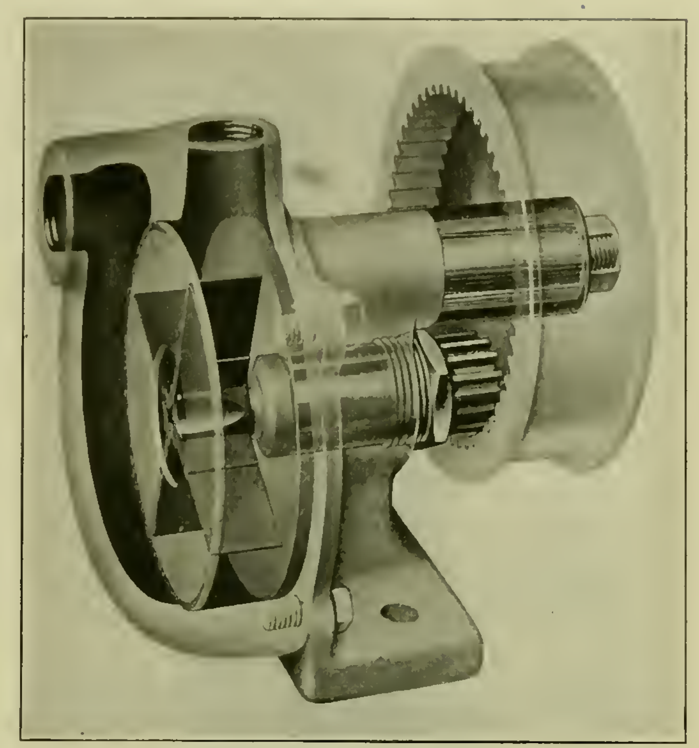
FOR delivering oil or water to drill presses, lathes, tapping machines, centering machines, screw machines, etc., whether the machines are running forward or in reverse, a two-way centrifugal pump, as illustrated, has been developed by the Ross Manufacturing Company, Cleveland, Ohio.

The Ross pump is designed to deliver a flow of liquid from the same outlet regardless of the direction of rotation of the impeller blades and from this ability to reverse instantly comes the name "two-way" pump. With machines which run in both directions such as screw machines, the pump must work in two ways, otherwise the machine will be without cooling compound when running in one direction. Where a battery of machines is cared for by a single pump, a reservoir is placed in the main distributing line with an overflow, thereby providing gravity feed for normal use, and where pressure is required the overflow is plugged.

The Ross pump is light, compact and neat, and is said to give a large and constant volume of any liquid, bringing the stream to the work without pressure. If pressure is required, however, the outlet nozzle is reduced in size and the pump speeded up. No priming is needed after the first time.

The pump is constructed with oilless bearings and graphite-asbestos packing and no bearings or gears come in contact with the cooling compound. This feature is important as steel chips are bound to mix with the compound and the bearings or gears cannot be expected to last long with steel chips being constantly ground through them.

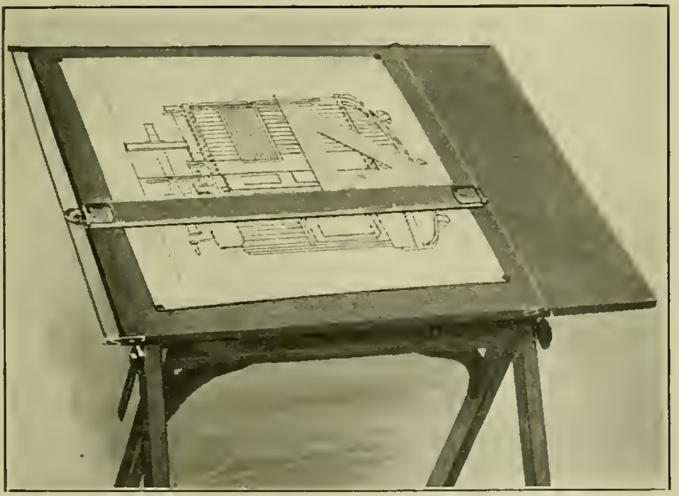
The impeller is composed of four light pieces of vanadium spring steel and the design is such that there is no end thrust. The pump can be mounted with the base in any one of four positions and is assembled with four hexagon-head cap screws, which simplifies disassembling. The gear ratio is four to one, giving a high impelled speed when belted to a slow pulley.



Ross Two-Way Centrifugal Pump

Precise Parallel Ruling Attachment

MANY advantageous features are combined in the parallel ruling attachment developed recently by the New York Blue Print Paper Company, New York. This device may be applied to any drawing board, large or small, and there are no cords or wires on the surface of the board to interfere with the work. In addition, all cords on the under side of the board are eliminated and metal parts are so designed that the drawing board can rest on a table or other piece of furniture and be moved from place to place without scratching the surface.



Precise Parallel Ruling Attachment

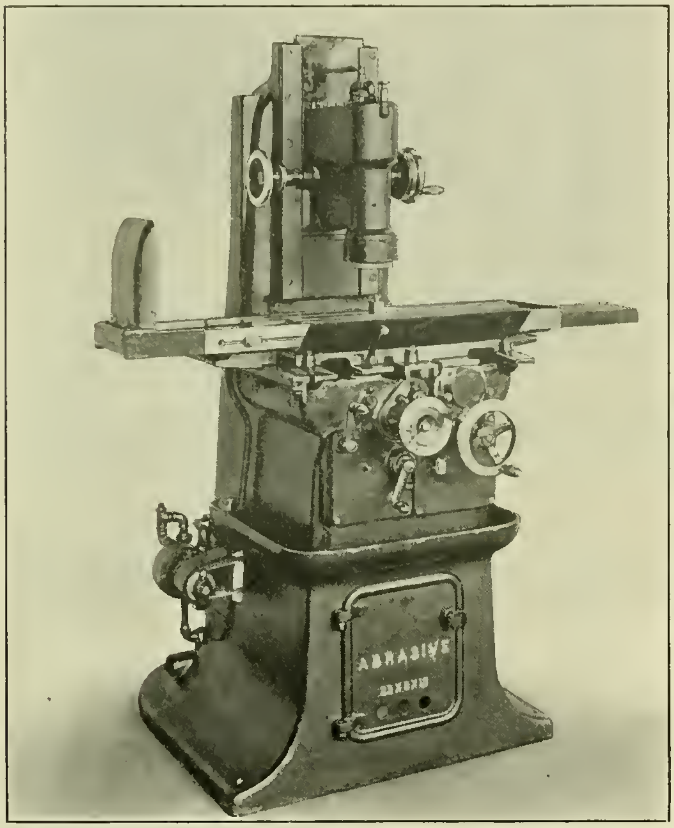
All metal parts of the attachment are made of aluminum and will not rust. Two plates are provided, one with a double pulley and the other with two small pulleys, to be applied to the ends of the straight edge. Four metal brackets are applied to the corners of the drawing board and a small metal grip is provided to hold the cord which guides the straight edge firmly.

The straight edge may be of any length desired, regardless of the size of the board, as shown in the illustration. In this case, tools, ink, etc., may be placed on the board at the right of the attachment without interfering with its operation. The double pulley acts as a T-square head since it is provided with a shoulder for that purpose and the cords running parallel are hidden in the straight edge. The pulleys are firmly and accurately attached to the straight edge and are given a careful test at the factory before shipment to insure perfect alinement.

An additional advantage of the Precise parallel ruling attachment lies in the fact that the straight edge can be simply and quickly adjusted to any angle desired. The attachment is stated to be accurate in every detail, convenient to manipulate and an efficient device for drawing room work. It is furnished complete in lengths varying from 24 to 60 in. and can be fitted with straight edges having crystalloid transparent lined, mahogany lined, and hardwood lined edges for various classes of work.

Vertical Spindle Surface Grinding Machine

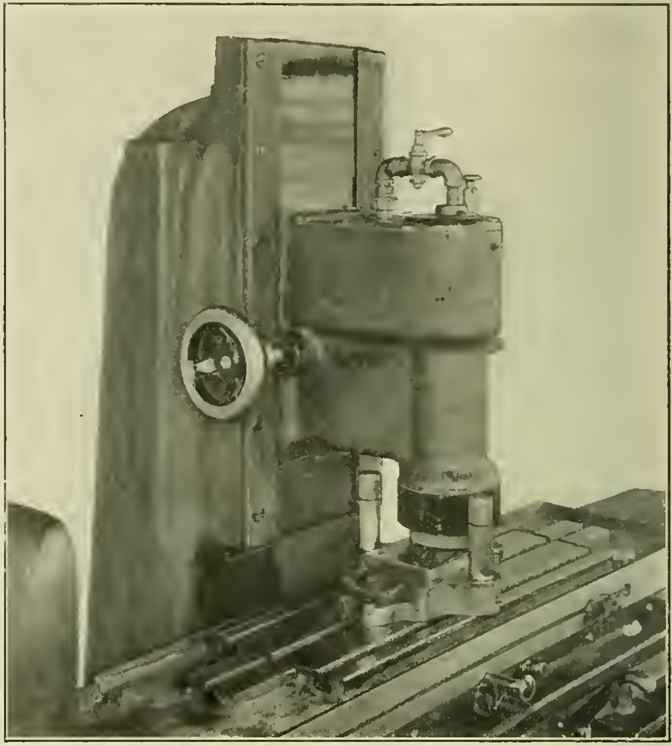
For several years there has been a demand for a small but sensitive vertical spindle surface grinding machine, not only for tool room use but for certain classes of production work, as for instance the squaring of shaft ends on centres, surfacing of small pieces held by magnetic chucks and re-sharpening pilot dies. Heretofore, the grinding of pilot dies has necessitated the use of a much larger machine of the horizontal spindle type in order to secure the large wheel diameter required to clear the pilots. By using the cupped wheel the cutting edges of the die are left sharp, whereas, with the disc style of wheel these edges are more or less "dubbed" over. The grinding time is also materially reduced.



Sensitive Vertical Spindle Surface Grinder

The machine illustrated has a capacity of 22 in. longitudinal feed, 8 in. transverse feed, both automatic, and 10 in. hand vertical adjustment. The wheel spindle is massive and carried on radio-thrust ball bearings. All of the high speed shafts are likewise carried on ball bearings. Wheels up to 5 in. in diameter can be used.

The adjustment of the wheel head is by means of a screw which is actuated by a worm and wheel. Two hand wheels are provided, one for fine feed being graduated to .00025 in. and one for rapid movements having an acceleration of 3 to 1. The gear case for the operating table and cross feed is a self-contained unit in which the gears and clutches run in a bath of oil.



Grinder Used for Sharpening Pilot Die

All belts are enclosed, also all dangerous moving parts, so that the safety of the operator is assured. All bearings are carefully guarded against the admission of dust or water. The machine, which is made by the Abrasive Machine Tool Company, East Providence, R. I., can be equipped with countershaft or concealed motor drive. Ample provision is made for use of water or a cooling compound.

Pilot Bar and Drill Press Chucks

The pilot bar type of chuck illustrated, which was developed recently by the Frontier Chuck & Tool Company, Inc., Buffalo, N. Y., was especially designed for work requiring piloted tools. Referring to Fig. 1, it will be seen that the air cylinder and the chuck are one complete unit and that the air source is at the back of the outer tube, the air being piped through the spindle of the machine on which the chuck is mounted. A revolving air box on the rear end of the spindle makes an ideal connection to the air valve. A tube is screwed into the piston which allows a pilot bar of any desired length to enter without interfering with any other part of the chuck.

Wedge spindles of the circular type and with flat inclined surfaces, which rest against the ends of the levers are held in place but free to revolve on the face of the piston by special nuts. The wedges, one for each jaw, rest against a similarly tapered surface on the end of the lever that is pivoted at the opposite end and pinned to a jaw at the center. Therefore, when the air is admitted to the cylinder the piston and the wedge spindles are forced forward, causing the levers to swivel on their fulcrums and bringing the jaws toward the center of the chuck. When the air is turned off, springs force the piston and jaws back to their original positions. It will be noted that the pilot bar is guided by the pilot bushing which is screwed into the face of this chuck and that the outer pilot tube has no movement whatever.

The drill press chuck, shown in Fig. 2, was developed for application on drilling machines and other machines where the chuck does not revolve. The chuck is provided with holes for bolting to the table of the machine. Its operation is similar to that previously described with the exception that the air is admitted at one side of the cylinder instead of the back. Due to the opening running clear through the center, danger of chips working into the operating mechanism is eliminated. Also, the base is raised on four legs about one inch high which allows the operator to rake out any chips that might accumulate by falling through the opening in the center. Both chucks are made with either two or three jaws, manufacturing or adjustable type, and in sizes, 10 in., 12 in., 15 in. and 18 in.

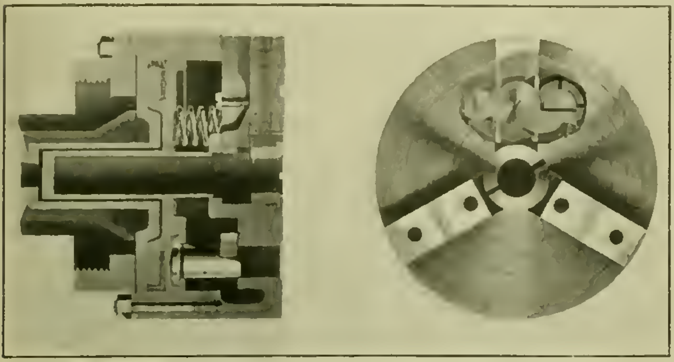


Fig. 1—Lavoie Pilot Bar Pneumatic Chuck

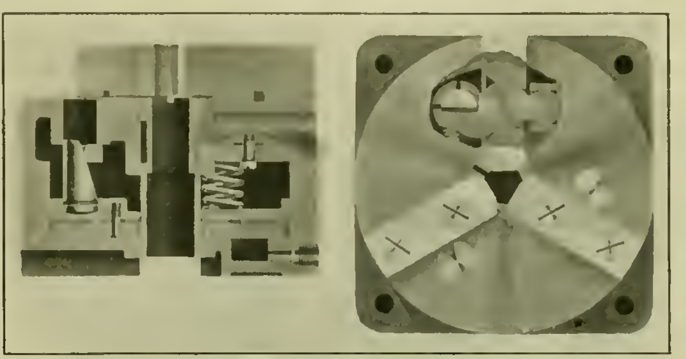


Fig. 2—Pneumatic Chuck Used on Drilling Machines

Die Heads for Railroad Shop Use

ALTHOUGH on the general market for several years, it is only recently that H & G automatic self-opening die heads, manufactured by the Eastern Machine Screw Corporation, New Haven, Conn., have been introduced for use in railroad machine shops. The range of sizes of die heads has been extended to cover the requirements of this work and two styles are provided designed to handle almost any threading job in the railroad field. Style *A*, a phantom view of which is shown in Fig. 1, is of the rotating type for use on automatic screw machines and bolt threaders. Style *C*, illustrated in Fig. 2, is of the stationary type for use on turret lathes, hand screw machines, etc.

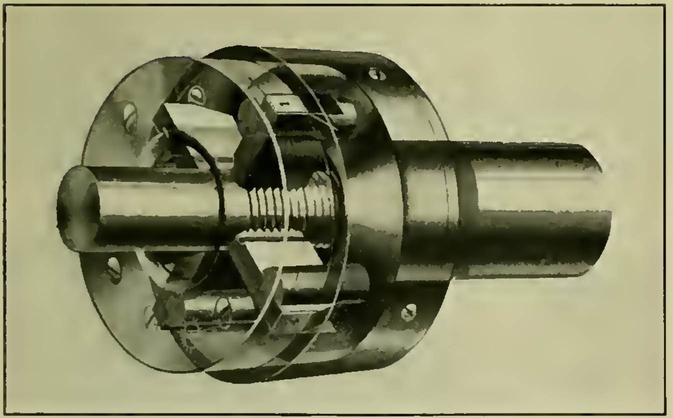


Fig. 1—Phantom View of Style A, H & G Die Head for Use on Automatics

The working parts of the die head are plainly illustrated and the same general working principle applies to both styles. The chasers slide in slots that are accurately ground and fitted. Sliding cams hold the chasers rigidly to the exact diameter desired and practically eliminate the possibility of faulty threads. In the design of these die heads every effort has been made to secure a high degree of workmanship, assuring parallelism and accuracy of leads in all threads cut.

All parts of the die heads are hardened, thus providing increased strength and greater wearing qualities. The heads are easily adjusted to accurate dimensions and each size will cut threads of various diameters and pitches with a change of chasers. The style *A* H & G die head is made in nine sizes for cutting threads up to 3 in. in diameter and the style *C* is made in six sizes for cutting threads up to the same size. Style *CC* is a special model made for Cleveland automatic screw machines and can be furnished in three sizes, having a maximum capacity of 1½ in.

Referring to the phantom view, the chasers are operated by cams having a positive bearing directly over the cutting edge. There are no springs used in closing the head. The cams are solidly supported by the body and the entire construction is characterized by simplicity. The chasers are hobbed, causing the threads to run true to leads and micrometer measurements. The chasers are made from specially selected high speed tool steel hardened to assure toughness, durability and long life. The chasers are interchangeable and may be used in any H & G die head of the same size, irrespective of style or date of manufacture. This feature allows a large number of sets to be carried in stock ready for prompt shipment.

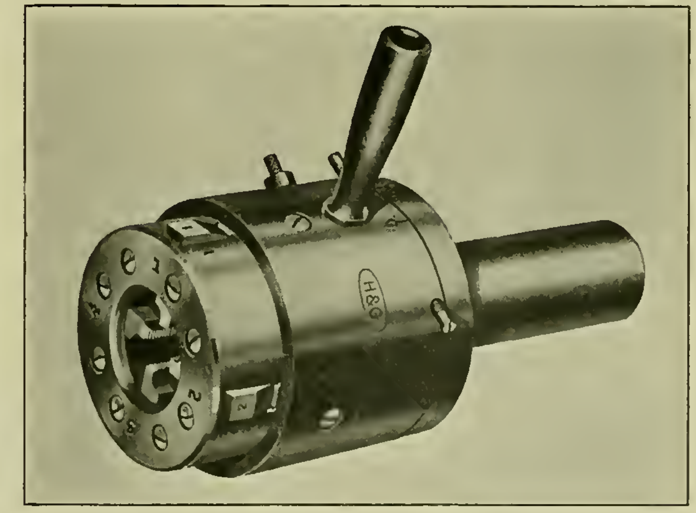
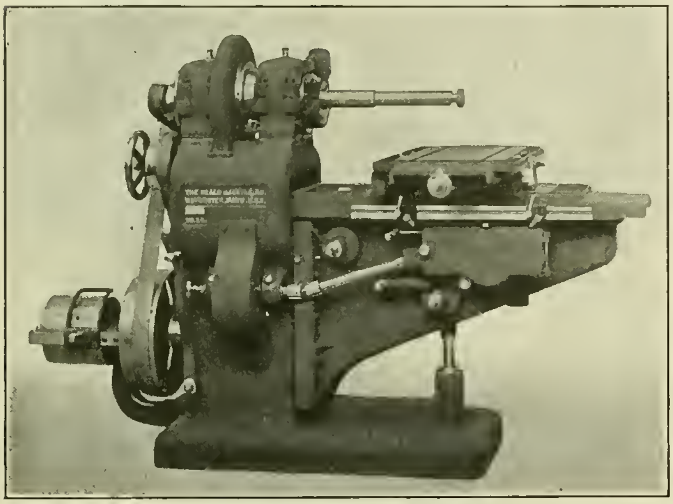


Fig. 2—Style C Die Head for Use on Turret Lathes, Hand Screw Machines, Etc.

Self-Contained Internal Grinder

THE Heald Machine Company, Worcester, Mass., has developed recently a new cylinder grinder known as style No. 55, for the re-grinding of cylinders and other internal grinding repair work. This machine differs from the Heald style 60 machine commonly used in railroad repair shops by the elimination of certain speed boxes and other expensive units. These are replaced by a drive from a single shaft on the rear of the machine. The machine is self-contained and a countershaft therefore is unnecessary. This is also an advantage since the machine may be belted directly from the main line drive and no time is required in setting up a countershaft.



Heald No. 55 Internal Grinder

In addition to simplifying the style 60 grinder, the new machine is provided with increased width for the knee and main table so that when grinding the extreme hole at either end in the larger castings, there is no undue overhang on either side. Also, the distance between the center line of the grinding spindle and the top of the cross slide table has been increased. On the style 60 machine, this dimension ranged from 4¼ in. to 7½ in. and on the style 55 machine, 7 in. is the minimum and 9½ in. the maximum. This feature is especially convenient when the machine is used for grinding holes in large castings, as is often necessary in railway shop work.

The eccentric and spindle arrangement on the style 55 machine is the same as on the style 60. As regular equipment, an arm is provided which grinds holes 2⅜ in. in diameter and over by 11 in. long; also holes 3 in. in diameter and over by 18 in. long. This arm is particularly desirable for certain classes of repair work and may be furnished in other sizes if desired. The advantages of the new style 55 Heald grinder may be summed up in the facts that it is self-contained, comparatively simple in construction and possesses a larger range and greater capacity than the style 60 machine. All of these advantages are particularly valuable for miscellaneous internal grinding work.

A Handy Forge for Heating Rivets

A LIGHT weight, portable rivet heating forge, which is stated to be economical and efficient in operation, has been placed on the market recently by the Norton Manufacturing Company, Boston, Mass. The forge may be readily moved from place to place by means of two folding handles. Two hooks are provided, as shown in the illustration, in case it should be desired to lift the forge by means of a crane to a scaffolding or other point adjacent to the work.

Reference to the illustration shows that the spent gases are vented through an opening in the top of the forge and pass upward away from the operator. This eliminates the necessity for the customary air curtain and is said to save in the neighborhood of 8 to 20 cu. ft. of compressed air per min. Rivets are manipulated through the top opening without discomfort to the operator and are always in plain view. No direct blast touches the rivets which are, therefore, subject to minimum oxidation. The forge may be regulated to provide only a mild soaking heat or the flame may be adjusted to keep rivets at a white heat.

A valuable safety feature results from the fact that no air pressure is required in the oil tank of this forge. A special vacuum burner is used which draws the oil from the tank, thus preventing leakage from all pipes and fittings due to pressure. The burner is simple in construction and operation, so designed as to burn low grade fuel oil or kerosene with an accurately controlled temperature. Standard fire brick are used in the forge and, therefore, it may be relined quickly and at a minimum of expense.

Starting with a cold forge, it is possible to heat rivets white hot in five minutes. The No. 2 Norton forge, illustrated, weighs 190 lb. and is 24 in. in height. It has a capacity to heat 350 ¾ in. by 3 in. rivets per hour. The oil tank has a capacity of 10 gal. In operation this forge is said to have shown an oil consumption of less than one gallon per hour and an air consumption of less than 4½ cu. ft. per min. On account of the fact that rivet forges are operated almost continuously, it is important that they should be economical in the use of fuel and air.

No. 2 Norton Rivet Heating Forge

Radial Drill Stand and Removable Drill

FOR bench drilling operations, particularly in railway tool rooms, the Hisey-Wolf Machine Company, Cincinnati, Ohio, has recently developed a tool which will be of special value. As shown in Fig. 1, the standard Hisey-Wolf portable drill of 1¼ in. capacity, which may be furnished in either the single or two-speed type, is mounted in a special head attached to a radial drill stand. The drill is held firmly in place by suitable clamps and is capable of adjustments, vertically and horizontally, as shown in the illustration. In addition, the drill holding head may be tilted at an angle with the base of the stand by means of the small hand wheel shown. A graduated collar facilitates setting the drill at any required angle. After necessary adjustments are made, the drill may be clamped firmly in the desired position and operation of a trigger starts the motor.

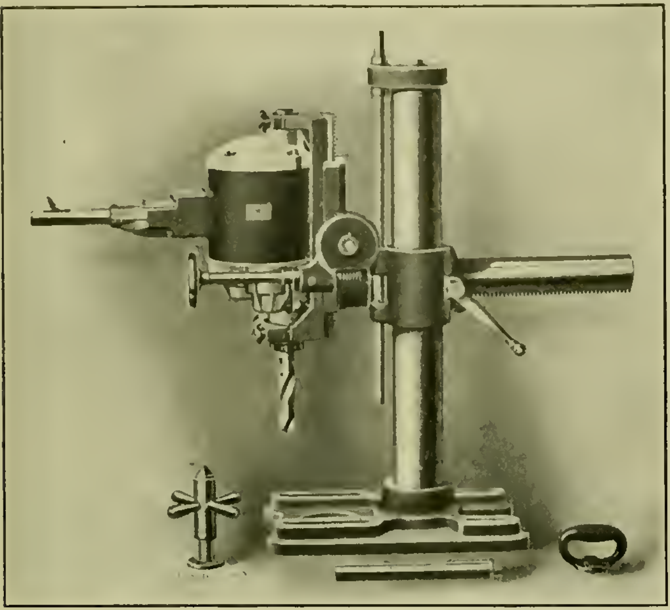


Fig. 1—Hisey-Wolf No. 3 Radial Drill Stand

The portable drill removed from the stand is shown in Fig. 2. It is evident that the field of usefulness of this drill is greatly increased since it may be used either as a portable or radial drill. Suitable slots provided in the base of the drill stand may be used to bolt it to a bench or table as desired. Dimensions of the No. 3 radial drill stand correspond to types "NM" and "NNA" radial drills manufactured by this company. When the No. 3 radial drill stand is ordered separately, the full name plate markings of the make of the machine, for which the drill stand is wanted, should be given.

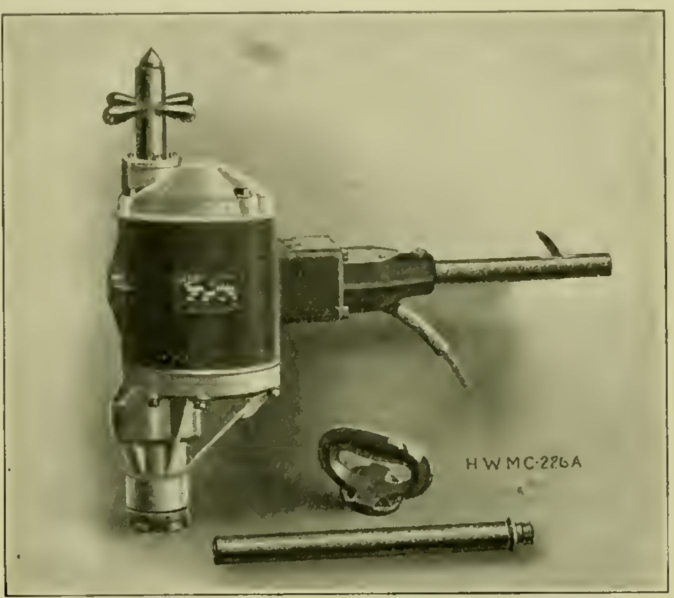
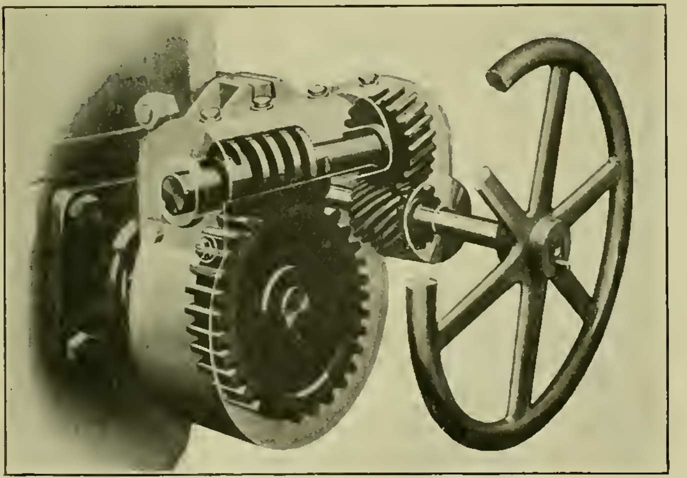


Fig. 2—Portable Drill Before Application to Stand

Helical Worm-Geared Crane Ladle

THE distinguishing feature of a new ladle designed by the Whiting Corporation, Harvey, Ill., is the fact that the gearing is mounted on the trunnion instead of on the bail. Consequently any distortion of the bail or bowl will not interfere with the alinement of the gears. The manner in which the gear bracket engages the bail is clearly shown in the illustration. A further advantage of this arrangement is that the gear alinement is not affected by wear on the trunnion journals.



Whiting Crane Ladle Tilting Mechanism

This gear combination, as illustrated in the phantom view, has the self-locking feature of worm gearing but by virtue of the balanced thrust obtained through the helical gears and the efficiency of the gearing being much higher than that of the ordinary worm gearing, the power required to rotate the ladle is considerably less. The helical gear on the hand wheel shaft meshes with a helical gear on the worm shaft. The work shaft is placed at an angle so that the worm will properly mesh with the large straight-toothed gear keyed to the trunnion. The latter gear is of cast steel; the worm and helical gears being made of forged steel. All gears have machine cut teeth. The construction of the gear case is such that it will accommodate several different ratios of helical gears, depending on the speed desired.

This new style of gearing is completely enclosed in a dust proof cover, yet is readily accessible for inspection. Small oil cups with spring caps provide ample lubrication. Crane ladles of this type are made in various sizes for both iron and steel.

Railway Mechanical Engineer

(*Formerly the* RAILWAY AGE GAZETTE, MECHANICAL EDITION
with which the AMERICAN ENGINEER *was incorporated*)

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WE GUARANTEE, that of this issue 10,500 copies were printed; that of these 10,500 copies, 9,460 were mailed to regular paid subscribers, 9 were provided for counter and news company sales, 266 were mailed to advertisers, 32 were mailed to employees and correspondents, and 733 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 31,000, an average of 10.333 copies a week.

The *Railway Mechanical Engineer* is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

The piece-work system has been restored in two departments of the foundry of the Pennsylvania Railroad at Altoona—the cleaning room and the wheel foundry.

The Landis Tool Company, Waynesboro, Pa., has announced its intention of reducing prices, commencing March 1, 1921, on all machines, with the exception of crankshaft grinding machines. The reduction on other types will average 15 to 20 per cent.

By a fire at the Pullman repair works at one hundred and eighth street and Langley avenue, Chicago, on the morning of January 27, a freight car shop was destroyed at a loss of about $450,000. Seven new refrigerator cars and 12 Pullman sleepers were also destroyed. The fire was the result of spontaneous combustion in one of the tool rooms.

W. J. Tollerton, general mechanical superintendent of the Chicago, Rock Island & Pacific, and chairman of the Mechanical Division of the American Railway Association, has been designated as American reporter to the International Railway Congress to be held at Rome, Italy, in April, 1922, on question No. VII—Passenger Carriages.

The United States Civil Service Commission announces an open competitive examination for senior mechanical engineers, Grade 1, salaries $3,000 to $5,000. A vacancy in the Bureau of Locomotive Inspection and vacancies in positions requiring similar qualifications at salaries ranging from $3,000 to $5,000, will be filled from this examination. Applications should be made on Forms 1312, which must be filed with the Civil Service Commission, Washington, D. C., not later than March 29.

Sir Robert Hadfield, inventor of manganese steel and a leader in the British steel industry, has been awarded the John Fritz gold medal for notable scientific and industrial achievement. Manganese steel, non-magnetic, was used in the manufacture of millions of helmets worn during the war by American, British and Belgian soldiers. Award of the medal was voted unanimously by the sixteen members of the committee representing the American organizations of civil, mechanical, mining, metallurgical and electrical engineers.

Freight Cars

The Delaware, Lackawanna & Western has ordered 40 caboose cars from the Mt. Vernon Car Manufacturing Company.

The Louisville & Nashville has ordered 1,500 box cars, and 100 40-ton stock cars from the American Car & Foundry Company; 500 box cars from the Mt. Vernon Car Manufacturing Company; 300 40-ton coke cars, and 300 55-ton gondola cars from the Chickasaw Shipbuilding Company.

Shop Construction

ATCHISON, TOPEKA & SANTA FE.—This company has awarded a contract for the construction of a one-story brick addition to its machine shop at Argentine, Kan., to Jerome Moss, Chicago, at an approximate cost of $45,000. The dimensions of the addition will be 102 feet by 115 feet, and the improvements to be undertaken include the construction of an office, tool room, engine pits and drop pits.

A. R. A. Names Executive Committee

The secretary of the American Railway Association, J. E. Fairbanks, has announced the personnel of the executive committee for the calendar year 1921 as follows: Division I, Operating, General W. W. Atterbury; Division II, Transportation, E. J. Pearson; Division III, Traffic, C. H. Markham; Division IV, Engineering, H. G. Kelley; Division V, Mechanical, W. B. Storey; Division VI, Purchasing and Stores, W. G. Besler; Division VII, Freight Claims, N. D. Maher.

Safety Appliances for Cars of Special Construction

The Interstate Commerce Commission at a conference held on December 6 adopted the following ruling regarding the application of safety appliances on cars of special construction:

Cars of special construction, as contemplated by the commission's order of March 13, 1911, are cars which cannot be equipped with safety appliances as prescribed in the order for any specified classes enumerated therein. In the construction of new equipment which does not conform to the specified classes designated in the order, plans shall be submitted to the commission prior to construction of such cars for the purpose of determining the location and application thereto of all safety appliances required by statute and the order of the commission of March 13, 1911.

Research Graduate Assistantships at the University of Illinois

To assist in the conduct of engineering research and to extend and strengthen the field of its graduate work in engineering, the University of Illinois maintains fourteen Research Graduate Assistantships in the Engineering Experiment Station. Two other such assistantships have been established under the patronage of the Illinois Gas Association. Each assistantship carries an annual stipend of $600 and freedom from all fees except the matriculation and diploma fees. There will be thirteen vacancies in addition to two in gas engineering to be filled at the close of the current academic year. The positions are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry. Nominations are made from applications received by the director of the Engineering Experiment Station each year not later than the first day of March and become effective the first day of the following September. Additional information may be obtained from the director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

MEETINGS AND CONVENTIONS

American Society of Mechanical Engineers.—The spring meeting of the American Society of Mechanical Engineers will be held at the Congress Hotel, Chicago, May 23 to 26. Sessions are planned by the professional sections on aeronautics, fuel, management, material handling, machine shop, power, forest products and railroads, the details of which will be made public later.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City. Annual convention May 3 to 6 inclusive, Hotel Sherman, Chicago.

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Next convention June 15-22, Atlantic City, N. J. Exhibit by Railway Supply Manufacturers' Association.

Division V—Equipment Painting Division.—V. R. Hawthorne, Chicago.

American Railway Association, Division VI—Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio. Second annual meeting June 20-22, Atlantic City, N. J.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamlin Ave., Chicago.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Spring meeting May 23 to 26 inclusive, Congress Hotel, Chicago.

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Next meeting March 8. Paper on "The Repairing of Steel Freight Cars" will be presented by Samuel Lynn, M. C. B., Fittsburgh & Lake Erie Railway Company, together with stereopticon views.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago. Meeting second Monday in month, except June, July and August, New Morrison Hotel, Chicago.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

Central Railway Club.—H. D. Vought, 95 Liberty St., New York. Next meeting March 11. Paper on "Engine Terminal Layout" will be presented by H. E. Stitt, chief engineer, Austin Company, Cleveland.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill. Next meeting March 3 and 4, 1921, Hotel Sherman, Chicago.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Meeting second Tuesday of February, May, September and November, Hotel Sinton, Cincinnati, Ohio.

Dixie Air Brake Club.—E. F. O'Connor, 10 West Grace St., Richmond, Va.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 715 Clarke Ave., Detroit, Mich. Next meeting August 16, 17 and 18, 1921, Hotel Sherman, Chicago.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago. Next annual meeting, May 24-26, 1921, Hotel Sherman, Chicago.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn. Convention, September 12, 13, 14 and 15, 1921, Hotel Sherman, Chicago.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York. Convention, May 23 to 26, 1921, inclusive, Planters' Hotel, St. Louis, Mo.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting March 8. Election of officers, together with annual entertainment.

New York Railroad Club.—H. D. Vought, 95 Liberty St., New York. Next meeting March 18. Paper on "Safety of Passengers in Steel Cars" will be presented by F. M. Brinckerhoff.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Fine St., San Francisco, Cal. Annual meeting Thursday, March 10, at 8 p. m. Election of officers.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Meetings fourth Thursday in month except June, July and August, Americus Club House, Pittsburgh.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Meetings second Friday in month except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Buffalo, N. Y.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Meeting third Monday each month except June, July and August.

PERSONAL MENTION

GENERAL

D. G. McCormick has been appointed mechanical engineer of the Mobile & Ohio, with headquarters at St. Louis, Mo.

C. J. Sevier has been appointed assistant to the superintendent maintenance of equipment of the Western Maryland, with headquarters at Hagerstown, Md.

O. C. Cromwell has been appointed assistant to the chief of motive power and equipment of the Baltimore & Ohio, with headquarters at Baltimore, Md.

H. W. Salmon, Jr., has been appointed acting fuel agent on the Missouri Pacific, with headquarters at St. Louis, Mo., succeeding W. P. Hawkins, who has resigned.

G. S. Goodwin, corporate mechanical engineer of the Chicago, Rock Island & Pacific, has been appointed mechanical engineer of the Rock Island System, with headquarters at Chicago.

J. W. Sasser, superintendent of motive power of the Norfolk Southern, has resigned to become superintendent of motive power of the Virginian, with headquarters at Princeton, W. Va., succeeding R. E. Jackson, resigned.

J. C. Garden, superintendent of motive power on the Grand Trunk Railway at Stratford, Ont., has been appointed acting general superintendent of the motive power and car departments of the lines east of the Detroit and St. Clair rivers, and consulting engineer of the motive power and car departments of the Grand Trunk Western Lines, succeeding W. H. Sample, retired. John Roberts, general foreman, has been appointed acting superintendent of motive power, with headquarters at Stratford, succeeding Mr. Garden.

P. O. Wood, superintendent of the St. Louis-San Francisco, with headquarters at Memphis, Tenn., has been appointed assistant superintendent of motive power with headquarters at Springfield, Mo. Mr. Wood was born at Memphis, Tenn., in 1877. He entered the service of the Kansas City, Memphis & Birmingham (now a part of the Frisco) in 1891 as a machinist apprentice in the Memphis shops. After completing his apprenticeship he served as a machinist and air brake repairman until 1904, when he became a locomotive fireman. In 1907 he was promoted to engineman and, in 1913, to assistant superintendent of locomotive performance. In 1916 another promotion made him assistant general superintendent of motive power. In 1917 he became division superintendent at Memphis and remained in that position until his recent appointment.

A. Sturrock, whose promotion to assistant superintendent of motive power on the Canadian Pacific, with headquarters at Winnipeg, Man., was announced in the February *Railway Mechanical Engineer*, was born on July 27, 1883, at Dundas, Ont. He entered railway service in 1901 as a machinist in the Stratford, Ont., shops of the Grand Trunk. After a year's service with the Grand Trunk, Mr. Sturrock came to the United States and was employed as a machinist, first on the Atchison, Topeka & Santa Fe, and later on the Denver & Rio Grande. His service with the Canadian Pacific began in July, 1904, when he was employed as a machinist in the company's shops at Winnipeg. He was promoted to locomotive foreman in 1911, with headquarters at Fort William, Ont., a position which he held until 1913, when he was transferred to Vancouver, B. C. In April, 1914, he was again promoted, being made general locomotive foreman of the shops of the Canadian Pacific at Ogden, Alta. A year and a half later Mr. Sturrock was made division master mechanic, with headquarters at Cranbrook, B. C., and in January, 1915, was promoted to general master mechanic of the Alberta district, with headquarters at Calgary, Alta. At the time of his recent promotion he was serving as general master mechanic of the British Columbia district at Vancouver.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

R. J. Rheaume has been appointed assistant master mechanic of the Canadian National Railways Hornepayne, Ont.

Eugene Schull has been appointed master mechanic on the Frisco System, with headquarters at Sapulpa, Okla., succeeding C. F. Coffman, resigned.

C. E. McGann has been appointed master mechanic of the Pittsburgh division of the Baltimore & Ohio, with headquarters at Glenwood, Pa., succeeding W. C. Burel, resigned.

A. J. Flowers, assistant master mechanic on the Central of Georgia at Macon, Ga., has been appointed master mechanic, with headquarters at Columbus, Ga., succeeding E. G. Gross, resigned.

H. M. Allen, locomotive foreman on the Canadian Pacific, with headquarters at Alyth, Alta., has been promoted to master mechanic, on the Kenora Division, with headquarters at Kenora, Ont.

A. G. Fischer has been appointed master mechanic on the Frisco System at Memphis, Tenn., succeeding G. R. Wilcox, who has resigned. William Henry succeeds Mr. Fischer as assistant master mechanic at Monett, Mo.

A. Devine has been appointed assistant master mechanic of the Canadian National Railways at Campbellton, N. B., succeeding F. F. Carey, who has been appointed assistant master mechanic of the St. Maurice division, at Quebec, Canada.

J. E. Gould, master mechanic of the Charlotte Harbor & Northern, with headquarters at Arcadia, Fla., has been appointed master mechanic of the Cumberland & Manchester, with headquarters at Barbourville, Ky. F. S. Market has succeeded Mr. Gould at Arcadia.

W. J. Denix, master mechanic on the Canadian Pacific at Moose Jaw, Sask., has been appointed master mechanic at Vancouver, B. C., succeeding A. Sturrock, who has been promoted to assistant superintendent of motive power at Winnipeg, Man.

J. Gibson, locomotive foreman on the Canadian Pacific, with headquarters at Sutherland, Sask., has been promoted to master mechanic, with headquarters at Moose Jaw, Sask., succeeding A. Peers, whose appointment as master mechanic was announced in the February issue.

G. W. Ray, master mechanic on the Western division of the Chicago & Alton, with headquarters at Slater, Mo., has been transferred to the Northern and Southern divisions, with headquarters at Bloomington, Ill., succeeding M. J. McGraw, who has resigned. F. Stone succeeds Mr. Ray.

H. A. Amy, locomotive foreman on the Canadian Pacific, with headquarters at North Bay, Ont., has been promoted to division master mechanic, with headquarters at Ottawa, Ont. E. G. Freeman, locomotive foreman, with headquarters at Cartier, Ont., has been transferred, succeeding Mr. Amy.

W. D. Hartley, whose appointment as master mechanic on the Atchison, Topeka & Santa Fe at Clovis, N. M., was announced in the February issue of the *Railway Mechanical Engineer*, was born on August 14, 1886, at Albuquerque, N. M. He was graduated from the high school at Las Vegas, N. M., in 1903, and in May of the same year entered the employ of the Atchison, Topeka & Santa Fe, serving as a machinist apprentice and machinist until September, 1909, when he became roundhouse foreman at Richmond, Cal. From October, 1914, to February, 1918, he was division foreman at Barstow, Cal., and from February, 1918, until his recent transfer as master mechanic, was general foreman at Richmond.

CAR DEPARTMENT

O. J. Greenwell has been appointed master car repairer on the Tuscon division of the Southern Pacific, with headquarters at Tucson, Ariz., succeeding A. G. Saunders, who has resigned.

A. J. Krueger, shop inspector of the New York, Chicago & St. Louis, with headquarters at Cleveland, Ohio, has been promoted to master car builder, with the same headquarters, succeeding R. W. Miller, deceased.

SHOP AND ENGINEHOUSE

W. T. Abington has been appointed night roundhouse foreman on the Rock Island at Herington, Kan., succeeding S. L. Hamilton, resigned.

SUPPLY TRADE NOTES

L. A. Lenhart, plant manager of the General American Tank Car Corporation, East Chicago, Ind., has resigned to become vice-president of the Youngstown Steel Car Company, Niles, Ohio.

The Atlas Valve Company, Newark, N. J., has secured the sole patents and rights to manufacture the Ideal automatic pump governor, by purchase from the Ideal Automatic Manufacturing Company, New York.

E. R. Lewis, editor of the Maintenance of Way Cyclopedia, one of the publications of the Simmons-Boardman Publishing Company, has been appointed officer engineer of the Michigan Central with headquarters at Detroit, Mich.

John L. Bacon has been appointed manager of the service and inspection department of the Franklin Railway Supply Company, with headquarters in New York. Mr. Bacon was formerly district manager of the Cleveland office of the same company.

The Black & Decker Manufacturing Company, Baltimore, Md., has opened a new branch office and service station at 75 Fremont street, San Francisco, Cal. This office has jurisdiction of the company's affairs over the entire Pacific coast territory and is in charge of F. A. Johnson.

B. A. Bell, railway specialist for the Western Electric Company, has been appointed railway representative of this company at Atlanta, Ga., succeeding J. W. Smith. Before taking up the duties of railway specialist Mr. Bell was general salesman for the Western Electric Company.

Theodore L. Dodd has been elected vice-president and a member of the board of directors of the Allegheny Steel & Tube Company, with headquarters at Chicago. Mr. Dodd will have jurisdiction over the sales in the Middle West, extending to the Pacific coast.

The Chicago Flexible Shaft Company opened an office at Detroit on February 1 for the sale and distribution of Stewart furnaces and to extend direct service in heat treating problems to customers in that territory. The new office is located at 601 Kerr building, and is in charge of George P. Beck.

A. T. Kuehner has been appointed mechanical engineer of the Standard Stoker Company, Inc., New York. Mr. Kuehner is the inventor of the Keener journal box for locomotive drivers and trucks. This device will be manufactured and placed on the market by the Standard Stoker Company. Mr. Kuehner, until his recent appointment, was on the staff of C. A. Gill, superintendent of motive power of the Baltimore & Ohio.

Max Grant, who has been associated with the Tropical Paint & Oil Company, Cleveland, Ohio, has been appointed manager of technical railway sales, of the Glidden Company, Cleveland, and M. F. Emrich, formerly vice-president and general manager of the Campbell Paint & Varnish Company, St. Louis, a subsidiary of the Glidden Company, has been appointed general sales manager of the industrial division of the Glidden Company, with headquarters at Cleveland.

Alba B. Johnson, formerly president of the Baldwin Locomotive Works, has resigned from the board of that company and also as a director of the Standard Steel Works, Philadelphia, Pa. John M. Hansen, president of the Standard Steel Car Company, Pittsburgh, has been elected a director and member of the executive committee of the Baldwin Locomotive Works and W. L. Austin, vice-chairman of the board of directors of the Baldwin Locomotive Works, has been elected a director of the Standard Steel Works, Philadelphia, to succeed Mr. Johnson.

Louis B. Rhodes, southeastern sales representative of the Vapor Car Heating Company, Inc., with headquarters at Richmond, Va., died of heart failure on January 25, at Nashville, Tenn. Mr. Rhodes was formerly master mechanic on the Georgia Southern

& Florida and had served as superintendent of motive power of the Virginian. Later he was with the Ward Equipment Company. He was in the service of the Standard Heat & Ventilation Company at the time when the latter company was consolidated with the Chicago Car Heating Company in the organization of the Vapor Car Heating Company.

The Brown & Sharpe Manufacturing Company has recently prepared a list of graduate apprentices who have completed the company's training courses during the seventy or more years that the apprenticeship system has been in use in the plant. In the Brown & Sharpe organization, the executives, with few exceptions, were formerly Brown & Sharpe apprentices. This list, though incomplete, contains the names of many now holding important positions and serves to prove that the apprenticeship course lays the foundation on which to build broadly and progressively. The company is sending these booklets to any former Brown & Sharpe graduate apprentice or to others who are interested in training courses and desires to add as many names as possible to the next edition.

The executive, sales, purchasing and accounting departments of the Reed-Prentice Company, the Becker Milling Machine Company and the Whitcomb-Blaisdell Machine Tool Company, 53 Franklin street, Boston, will be located on and after February 21 at the Reed-Prentice plant, 677 Cambridge street, Worcester, Mass. On account of present business conditions, the Becker plant at Hyde Park, Boston, is operating with reduced force, production to be increased as soon as conditions warrant. The Becker cutter department business showed a marked increase in volume during January and it is expected to be running full capacity shortly. The Worcester plants of the Reed-Prentice and Whitcomb-Blaisdell Machine Tool Company are completing orders on hand, and are also building machines to be placed in stock.

The Toledo Crane Company, Bucyrus, Ohio, successors to The Toledo Bridge & Crane Company, Toledo, builders of Toledo cranes, has been chartered under the laws of Ohio, with the following officers: C. F. Michael, president; W. F. Billingsley, vice-president and general manager; A. G. Stoltz, treasurer, and C. Gallinger, secretary. The officers with C. H. Dexheimer are the stockholders and directors. All stock has been subscribed and paid in and none will be offered for public subscription. The main office is at Bucyrus with sales offices in New York City, Boston, Philadelphia, Pittsburgh, Buffalo, Cleveland, Cincinnati, Chicago, St. Louis, Kansas City, Seattle, Salt Lake City, San Francisco, Birmingham and Minneapolis. The company will have completed by March 15 a building 120 ft. by 320 ft., to be used for erecting and assembly, with a machine shop 60 ft. by 300 ft., a structural shop 90 ft. by 300 ft., a pattern shop 60 ft. by 140 ft., and a forge shop 40 ft. by 100 ft., all to be equipped with modern tools.

Clifford J. Ellis, district manager of sales for the Midvale Steel & Ordnance Company and the Cambria Steel Company, with headquarters at Chicago, Ill., died at his home in Evanston, Ill., on January 31. Mr. Ellis had been district manager of sales for more than 30 years and for 37 years had been in the service of the Cambria Steel Company at Chicago. He was born on November 25, 1860, and when 19 years of age entered the employ of Wood Morrell & Co., Johnstown, Pa., who controlled the Cambria Iron Company. Not long thereafter he became assistant to the treasurer and in 1883 he was transferred to Chicago, entering the sales department of the company, where he had served up to the time of his death.


C. J. Ellis

Harry M. Evans, eastern sales manager of the Franklin Railway Supply Company, Inc., has been elected vice-president of the company, with offices at 30 Church street, New York. Mr. Evans was born at Meadville, Pa., and was educated in the public schools at that place. He began railroad work as a call boy on the Erie, and served in various positions in the mechanical, transportation and traffic departments of that road. He entered the mechanical department of the Franklin Railway Supply Company in October, 1908, as traveling representative. In August, 1916, he became assistant western sales manager, and in January, 1917, was appointed eastern sales manager, which position he was holding at the time of his recent election.


Harry M. Evans

E. Emery, formerly manager of the R. H. Blackall Company, Pittsburgh, Pa., has opened offices in the Oliver building, Pittsburgh, under the firm name of the Emery Sales Company, handling railway supplies. Mr. Emery will serve as special representative, reporting to the Pittsburgh office of the Schaefer Equipment Company, handling its full line of foundation brake details in a defined territory. He will also have charge of sales in the Pittsburgh district of the Mason Packing Company, Pittsburgh, which manufactures the Mason semi-metallic packing for locomotive air pumps, and will represent the Standard Horsenail Company, New Brighton, Pa., handling its line of taper pins, shaft keys and channel pins. Mr. Emery was graduated from the Chicago Manual Training School in 1899, after which he was connected for two years with the F. B. Reddington Company, Chicago, in an engineering capacity. He was for eight years with A. Sorge, Jr., & Company, Chicago, handling a steam specialty line. He was engaged in sales and engineering work for a time and later was with the Parker Boiler Company, Philadelphia, Pa., for one year as general sales manager. Mr. Emery was then assistant sales manager of the Rust Boiler Company, Pittsburgh, and when that business was sold to other interests he joined the R. H. Blackall Company.


E. Emery

Locomotive Superheater Company Takes Over Locomotive Feed Water Heater

The Locomotive Superheater Company, New York, has acquired the patents and business of the Locomotive Feed Water Heater Company, also of New York. Feed water heating and superheating have many factors in common, and logically the former can best be perfected by a combined organization broadly experienced and trained in this field. During the past few years remarkable progress has been made in successfully adapting feed water heaters to locomotives, and if the thermal efficiency of the locomotive is to be further increased, the development of the feed water heater should be conducted with a full knowledge of the engineering features of the superheater.

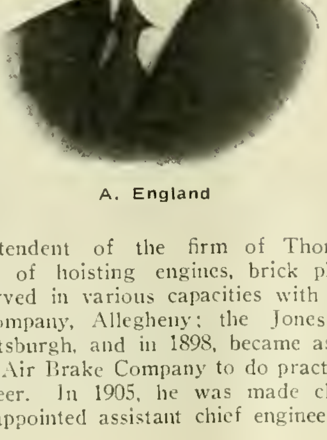
The Locomotive Superheater Company will conduct the further application of the apparatus for preheating feed water through its regular engineering, inspection and service organizations, to which has been added the operating organization of the Locomotive Feed Water Heater Company. This consolidation of resources and effort promises more intensified development and better service to the railroads.

Westinghouse Air Brake Company

S. W. Dudley, chief engineer of the Westinghouse Air Brake Company, Wilmerding, Pa., retired on February 1 to accept a professorship of mechanical engineering at Yale University.

S. W. Dudley

Mr. Dudley, who is a graduate of Yale University, had been associated with the air brake company for 17 years. He spent the summers of the years 1903 and 1904 in the plant as a special apprentice, returning to school to complete a post graduate course during the other seasons. In 1905, he established permanent connections with the Westinghouse Air Brake Company and assisted in and compiled much of the data pertaining to the tests of the Type R triple valve on the Pennsylvania, and the ET equipment and the Type R passenger triple valve on the New York Central. In 1906 he was assigned to the New York office to follow the installation, operation and maintenance of new air brake equipment that was placed in service on electric locomotives and motor cars during the inauguration of the New York Central's terminal electrification and, in 1907, returned to Wilmerding to take charge of the air brake publicity department. From 1909 until his appointment as chief engineer in 1914, he served as assistant mechanical engineer and assistant chief engineer (in charge of operation).



A. England

Alexander England, who has been appointed chief engineer to succeed Mr. Dudley, has been a member of the air brake organization for the past 22 years and, since 1914, has served as assistant chief engineer. He was born in Dundee, Scotland, and at an early age entered the employ of the Scotch firm of Pierce Brothers, engineers and shipbuilders, to serve an apprenticeship and finished a course of study that earned him a diploma in mechanical engineering from the City and Guilds of London Technical Institute, he entered the service of the Mercantile Steamship Company of London as an engineer in the Mediterranean and Black Sea trade. In 1887 he left the marine service and went to Pittsburgh, Pa., where he took a position as assistant superintendent of the firm of Thomas Carlin's Sons, manufacturers of hoisting engines, brick plant machinery, etc. Later he served in various capacities with the Specialty Manufacturing Company, Allegheny; the Jones & Laughlin Steel Company, Pittsburgh, and in 1898, became associated with the Westinghouse Air Brake Company to do practical work under the chief engineer. In 1905, he was made chief draftsman, and in 1914 was appointed assistant chief engineer.

TRADE PUBLICATIONS

Hand and Machine Tools.—The McCrosky Tool Corporation, Meadville, Pa., has issued a 64-page illustrated catalogue descriptive of their various types of tools, such as reamers, chucks, lathes, milling machines, etc. The catalogue is divided into several sections, each section being devoted to a detailed description of a particular tool. Prices and specifications are also given.

Locomotive Cranes.—A catalogue of detailed parts of Brownhoist locomotive cranes has recently been issued by the Brown Hoisting Machinery Company, Cleveland, Ohio. All the parts are shown in photographs in which each detail is clearly numbered to facilitate identification for ordering. The book also contains illustrated directions for erecting and operating these locomotive cranes.

Belting.—"A Saving for Every User of Belting" is the title of a new and interesting catalogue published by the Stanley Belting Corporation, Chicago, Ill. Aside from the general features of a well-worked out descriptive book, it gives valuable instructive points and considerations for every user of belting. The results of a test of Stanley belting are given and several typical installations are shown.

Wrought Iron and Steel.—The Reading Iron Company, Reading, Pa., has issued Bulletin No. 2 in which the structural differences between wrought iron and steel and their relation to the field of welded pipe have been described in a simple way. Photomicrographs of wrought iron and steel are shown and the structure of the two materials is discussed in a manner that is of interest to the layman as well as the engineer.

Gate, Globe, Angle, and Check Valves.—The Walworth Manufacturing Company, Boston, Mass., has issued a six-page folder which illustrates the diversified line of brass valves which this company manufactures. A list is included showing the sizes in which the various types are manufactured and giving a list of prices. The circular calls attention to the fact that the Walworth Manufacturing Company has been making valves since 1842.

Radial Flow Heater.—Catalogue F, issued recently by the Ross Heater & Manufacturing Company, Inc., Buffalo, N. Y., contains 39 pages devoted to the description and illustration of the two general types of Ross heaters. One of these types is the radial flow instantaneous heater, in which the liquid is heated as it is used. The other type is the storage heater, which, as the name implies, has a storage capacity to be drawn on in emergency. Several examples of each type of heater are given.

Injectors.—The new 1920 catalogue, issued by William Sellers & Co., Inc., Philadelphia, Pa., is a well arranged and fully illustrated book. It is divided into six sections, the first section being devoted to a description of the various classes of injectors. Main check and stop valves are described in section two; steam valves, in section three, and locomotive feed water strainers, ejectors, etc., in section four. A table and diagrams of tests are given in section five. Hints for the maintenance and repair of injectors are also included.

Transveyors.—A new edition of the Transveyor Picture Book has been issued recently by the Cowan Truck Company, Holyoke, Mass. This presents in an attractive book form the advantages and many possible uses of the Cowan transveyor. The photographs were taken at random from a great variety of industries and tell a forceful story without many words. Present models and specifications of the Cowan transveyor are given, and a two-page diagrammatic chart showing structural features and advantages is included.

Performance of Steam Boiler Plants.—Brownlie & Green, Ltd., Manchester, England, have recently reprinted an article by David Brownlie entitled "Exact Data on the Performance of Steam Boiler Plants. Average Figures for the Performance of Some Different Types of Steam Boilers." The author points out that the figures usually taken in practice are entirely erroneous and presents data obtained as a result of investigations during ten years on nearly 500 boiler plants, giving the average figures for different types of boilers.

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CONTENTS

EDITORIALS:

- Are Wage Reductions Necessary? 207
- What Is the Other Fellow Doing? 208
- Machine Tool Obsolescence 208
- Save Time in Valve Setting 208
- An Eye to the Future 209

COMMUNICATIONS:

- Selecting Foremen 209
- New Books 210

GENERAL:

- Notes on the Comparison of Locomotive Dimensions 211
- Stoker Fired Locomotive Makes Continuous Run Over Three Divisions 215
- Design of an Improved Locomotive Throttle Valve 216
- A New Rod Design 218
- Railway Executives Testify Before Labor Board 219

CAR DEPARTMENT:

- The Safety of Passengers in Steel Railway Cars 223
- Adjustment of Brake Power on Tank Cars 227
- Emergency Truck for Car Repairs 228
- Virginian 120-Ton Cars 228
- Draft Gear Tests of the Railroad Administration 229
- Car Inspectors and Foremen Propose Changes in Rules 233
- Relative Effect of Time and Service on Car Deterioration 238
- Straightening Car Ends with a Pull Jack 239

SHOP PRACTICE:

- Progressive Failure or Fatigue of Metals Under Repeated Stress. 240
- Wrecked Shear Reclaimed by Oxy-Acetylene Welding 241
- Gage for Calipering Driving Wheels and Tires 242
- A Locomotive Repair Shop Scheduling System 243
- Welding Locomotive Cylinders 247
- Application of Shoe and Wedge Liners to Driving Boxes 248
- Tapping Radial Holes in Boiler Shells 248
- An Easily Made Babbitting Furnace 248
- Making a Drill Live Up to Its Reputation 249
- Driving Box Chuck 250
- Curing Troublesome Frame Failures 252
- Piston Rod Centering Sleeve 252
- Hardening Hammer Die Blocks 252

NEW DEVICES:

- Lamont Six-Wheel Truck for Freight Cars 254
- Adaptability Secured in New Post Drill 256
- Rotary Wire Brush for Cleaning Operations 257
- Duplex Compensating Suspension for Tractors 257
- Automatic Valves Reduce Boiler Shut Downs 258
- Cone Drive Plain Milling Machine 259
- Gap Crane Saves Erecting Shop Headroom 259
- Heavy Duty Ball Bearing Dry Grinder 261
- Rigidly Constructed Auto-Transformer Starter 261
- Spring Threading Tool of New Design 262
- Combination Clutch Brake for Shaping Planer 262
- Redesigned Trip Levers for Die Heads 263
- Electric Hammer Drill of Novel Design 263
- Fibrous Metallic Packing for General Use 263
- Simplicity Features New Oliver Lathe 264
- Plate Press with Sectional Dies 264
- Headlight Combines Strength and Lightness 264
- Improvements in Twist Drill Grinder 265
- Rotary Table for Milling Machines 266
- Combination Grinding and Buffing Machine 266
- Change in Safe End Taper 266

GENERAL NEWS:

- Notes 267
- Meetings and Conventions 269
- Personal Mention 269
- Supply Trade Notes 270
- Trade Publications 272

Are Wage Reductions Necessary?

The most momentous question of the day on the railroads is readjustment of working rules and wages. At present the question promises to revolve into a heated controversy. In discussing this matter it may be enlightening to depart somewhat from the evidence presented at Chicago and consider for a moment the existing economic conditions to determine whether they indicate that a reduction in wages is justifiable or not.

No one will deny that there has been a serious slump in business all over the country. Factories are working intermittently; millions are idle. The number of cars loaded weekly has declined to 70 per cent of what it was last fall. For the week ending February 23 there were 423,193 cars standing idle. Economists are generally agreed as to the cause of the present depression. The international situation caused a sharp decline in the prices of farm products. Other prices did not drop at the same time. Therefore, after the decline the farmers' goods would purchase relatively a much smaller amount of other commodities. In other words, the purchasing power of the farmer had declined. Farmers form a very large proportion of the population and it is natural that when they curtail purchases, business should be bad. There are economic forces which, if allowed to operate normally, work out a natural balance between industries and occupations. That balance must be sustained in order that the products or services of each group may be absorbed by all the other groups. When the balance is lost, unemployment results and continues until a redistribution is worked out so that everyone is at work and all products are absorbed.

The secret of prosperity is in balanced industry with the production of every branch of industry in proportion to the wants and buying power of the people in all other occupations. The number of people that can be employed in any industry depends on the demand for the product, which in turn depends on the price. If the price of a commodity is increased, the consumers will have to curtail their purchases of it, or of something else. Individuals or groups may fix prices or wages, but they cannot govern the effect their action will have upon sales. This is made very plain by present conditions. Dealers object to cutting prices and labor organizations object to reductions in wages. They have been successful in holding out, but their prices are too high for the farmers and business is stagnant because the adjustments necessary to restore equilibrium are not made. It is shortsighted to think that wages can be fixed under all conditions by agreement between employer and employee. There is a relationship between each industry and all other industries that must be taken into account. What is needed now is a readjustment of the relationship of prices of farm products with other prices and wages. It would be difficult, if not impossible, to control the international conditions that govern the prices of farm products in order to cause these prices to rise. The only other course that will restore the balance of industry is to bring other prices and wages down.

This is not an argument for reducing the wages of railroad employees only. Other wages and prices must come down also. Neither is it the intention to propose that the reduction should be of the same magnitude as the drop in farm products. Nevertheless, it is worse than foolish—it is futile—for any group of employees to oppose a moderate reduction of wage rates. As the cost of living is declining a reduction at this time will be more apparent than real.

The modern industrial organization is dependent upon intelligent, voluntary and harmonious co-operation on the part of all the people. It requires that the people shall distribute themselves in the various industries and so direct their individual policies as to keep the industries in balance and effect a ready exchange of products. If through mistaken ideas of self-interest they organize themselves into groups and become so intent upon forwarding group interests that they lose sight of the necessity for general co-operation, the whole modern system of highly developed and highly specialized industry will break down.

What Is the Other Fellow Doing?

It is well known that a country cannot expand commercially without adequate means of transportation. It is equally true that the industries of a country cannot grow in efficiency and economy without some method of spreading general knowledge regarding improved machinery and methods which have demonstrated their value. While in some respects railroad shops are decidedly different from manufacturing plants and are confronted by different problems, certain fundamental conditions and problems are the same. Among these is the absolute necessity of keeping in touch with late developments and practices which have proved big time and money savers. Mechanical department officers on the whole are awake to this necessity, and no new railroad repair shop is now constructed without first making a careful and detailed study of existing plants with the idea of incorporating all possible good features and avoidi ngbad ones. The annual June convention of the American Railway Association, Division 5—Mechanical—offers a wonderful opportunity for railroad men to interchange ideas and benefit by the inspiration which comes from contact with capable, experienced officers who daily meet the difficult problems arising in the repair and maintenance of cars and locomotives in a serviceable condition. The technical papers also afford a fine opportunity for careful readers to keep abreast of the times and in touch with the most modern, approved shop practices.

One avenue of information has been sadly neglected, however, due to the short-sighted policy of some roads in not allowing their gang leaders and foremen to visit other shops and attend conventions. For example, the leading tool maker of a large railroad shop desired to attend the convention of the American Society for Steel Treating held at Philadelphia last year. This man's service with the railroad had been entirely satisfactory and he desired to profit by the wealth of information on the heat treatment of high speed tool steel available at the convention. He was told that no expense money could be allowed but in spite of this fact attended the convention for two days, and returned to his position with definite information, the actual cash value of which to his company would be hard to estimate. It is true that this tool maker was furnished with transportation to and from the convention, but his hotel expenses were paid out of his own pocket and he was required to lose two days' pay for the time he was absent from the shop. Can there be any excuse for such a penny wise and pound foolish policy? It is recognized that owing to the magnitude of the railroad industry, indiscriminate traveling cannot be tolerated. There is no reason, however, why the prohibition of educational trips should be so hard and fast that ambitious workmen or foremen must be at a financial loss in acquiring information which may well mean thousands of dollars annual saving for the railroads with which they are connected.

Machine Tool Obsolescence

The word obsolescence is defined as "the state of being out of date; disused." Unfortunately a large amount of the machinery and equipment used in railroad shops is obsolete to the extent that it has gone out of date and can no longer be efficiently operated. Even more unfortunate, however, is the fact that the second part of the definition does not apply since this machinery is now being used, no matter how uneconomically, and at a considerable cost for labor and delayed repair work. It may be dangerous to draw comparisons, but a prominent automobile manufacturer stated recently that he could not afford to operate machine tools, for example, after they are two years old. In this length of time they have earned their cost many times over and if not readily salable as second-hand tools, they are scrapped in favor of more efficient, productive types. Admitting the fundamental difference between railroad shops with diversified repair work and automobile plants manufacturing standard products, there is no reason why railroad shops should swing to the other extreme and be required to operate with machines indefinitely old. Two years is an extremely low estimate of the useful life of machine tools, but some reasonable period, as for example 10 years, should be decided on and used as a basis in accounting for depreciation. Developments in the design and improvement of machine tools are so rapid that most machines 10 years old are hopelessly out of date as production tools and can no longer be used economically in shops handling any considerable amount of work. Especially in the centralized production departments of railroad shops is it necessary and good economy to employ only modern, high capacity machines. Old machines should be retired and this can be accomplished by setting aside annually an amount of money equal to 10 per cent of the value of railway machine shop tools, charging it to the depreciation account. Then, at the end of the 10 years, it will be possible for the shops to benefit by the installation of new and improved machinery which is not held up due to difficulty in obtaining the necessary capital. The high cost of labor and the high cost of equipment held out of service, combined, make it imperative that obsolete machinery and shop tools be replaced as fast as possible by modern productive machinery.

Save Time in Valve Setting

There is one operation in setting locomotive valve gears which may be materially speeded up, especially in some shops, without in any way reducing the quality or accuracy of the work. The operation referred to is revolving the main driving wheels in valve setting to obtain the dead centers, lead, cut-off and travel marks. In many shops the driving wheels are now revolved at a considerable expense of time and physical effort, the common method being to relieve the spring weight on the wheels as much as possible, apply rolls beneath them and draw the rolls together until the wheels just clear the rail. Hand operation of the rolls by a long handled ratchet revolves the wheels. The difficulty with this method is in the large amount of physical effort required to turn the rolls, which in many cases slip and do not make the wheels revolve. A considerable proportion, possibly 35 per cent, of the time required to set valves is now spent turning the driving wheels, and the remedy for this condition is rapid power revolution of the driving wheels in valve setting. In some cases, air motors have been applied to the rolls, thereby reducing materially the labor involved, but the results with this method have not been wholly satisfactory due to continued sticking and slipping of the wheels. Some device of greater power should be provided. It is possible to design a set of power driven rolls of rugged construction, sufficiently large in diameter to eliminate practically all slipping between the rolls and the driving wheels. An efficient form of drive for such a mechanism has already been devised in the application of an electric motor to a four-wheel truck, connected to the rolls by a powerful, universal joint. With the weight relieved from the main driving boxes and a sufficiently powerful motor to drive the rolls, no difficulty will be found in revolving the driving wheels. The time saved by rapid power revolution of driving wheels in valve setting is doubly important because it occurs during the last day or two the locomotive is held in the shop for repairs. The reduction of this time by one day for one locomotive would more than pay the cost of a set of new power rolls.

An Eye to the Future

It would be difficult to conceive of circumstances more trying to the men in the car department than exist at this time. Ever since 1917 the problem of keeping equipment in condition has been a difficult one. The percentage of bad order cars has been high and freight cars have been used so intensively that little progress has been made in getting them repaired, except during a few short periods of light traffic. Now that cars are being returned to the owning roads and large numbers are idle, the conditions are favorable for doing a good deal of repair work, but the critical financial situation of many of the railroads makes this impossible. Cars reaching the home road are merely being set aside and bad orders are steadily increasing. The number of unserviceable cars on March 23 was 459,411, the highest figure ever recorded.

There is no question that immediate economies are called for, but it would be a mistake to allow this to interfere with the problem of future repairs. The cost of almost any work can be materially reduced if it is carefully planned in advance. In car work there has been too much of a tendency to leave the decision as to how to handle the job to the repairman. This has resulted in costly methods of doing work without efficient specialized equipment. Furthermore, it has led to waste through repeated replacement in kind of parts that should have been strengthened. This is an opportune time to lay plans for correcting wrong conditions. As cars are bad ordered, they should be carefully inspected with the ideas mentioned above in mind. If a large number of one class need heavy repairs, a schedule for handling the work can be outlined. By obtaining material in advance and systematizing the operations, work can be greatly expedited.

Some classes of cars are continual sources of trouble, and under normal conditions would have been retired without question. There has developed in recent years a practice of keeping cars in service almost irrespective of the amount of repairs required, though this is in many cases the costliest policy that could be followed. The old equipment of low capacity often shows a high repair cost per car. If the figure is changed to the cost per ton of capacity, it is still higher, and if it could be ascertained on the basis of the ton mile, it would probably be startling. This is the measure that should be applied when deciding what cars are not economical to repair. Traffic is certain to increase again, and when that time comes the roads cannot afford to put up with the interruptions to traffic and the handicap to the shops that would result from keeping a large number of old, weak cars in service.

The Temperature at Which carburizing should be carried out should be just above the critical temperature of the steel, or 1650 deg. F., generally speaking. To operate at a lower temperature will decrease the rate of penetration, thus increasing the cost, and to operate at a very much higher temperature will not only produce a very high carbon surface with its tendency to crack and peel, but may burn the pieces beyond reclaiming. Correct known temperatures are essential to success.—*The Melting Pot.*

COMMUNICATIONS

Selecting Foremen

Washington, D. C.

To the Editor:

In the March number of the *Railway Mechanical Engineer*, views are asked as to what training a foreman should have. When this was read a man of wide railroad experience happened to be near and he was asked the question as to what is necessary to make a good foreman. The answer came, quick as a flash, "They can't be made." "You mean they have to be born?" "Yes," was the answer.

This question of foremen is one that all of us have given considerable thought ever since the day we were trying to determine the requisites in order to qualify ourselves for a foreman's job. There is more truth than poetry in the statement that foremen have to be born, but it is really only a half truth, as numbers of men have been made, some actually hand-molded. What, then, is necessary—can the points be defined—is it possible to take a man's measure and determine accurately whether he is a potential official?

In the "box" calling for views on this subject, the statement is made that as a rule the best mechanics are selected for minor officials. If this rule were followed blindly, we would soon be shipwrecked, as it has nothing whatever to do with a man's capacity to accept and profit by advancement and should be only incidental.

It is necessary to study a man for some time to determine his capabilities. First, is he honest in every way? Second, is he substantial, that is, dependable in an all around and general way? Next, is he subject to the influence of other men in the shop; is he prejudiced or narrow-minded? Who are his associates and what does he do with his spare time? Is he ambitious and does he feel that railroading offers ample opportunities to make him anxious to make it his life work? Does or can he exert good influence over men, and can he talk forcibly—to the point and with conviction when necessary? Will he study his job and endeavor to perfect himself in the profession, realizing that there are many angles to it and many units that go to make up the whole? Last but not least, can he control himself and thus permit his mind to function properly in times of dire stress or emergency?

Human nature is the same yesterday, today and tomorrow, but there is too much loose talk going the rounds about men having no ambition and about it being well nigh impossible to recruit the quota of minor officials. Because you "happen" to pick out four or five men and ask them how they would like to take Jim Jones' place and they state that they would prefer to remain in the ranks, it does not follow that such a conclusion is correct. The trouble is really with the management, for a live organization will assure itself at all times of sufficient potential officials, as otherwise it will deteriorate and eventually fail. We anticipate our needs on other scores and must do so for future foremen. It has been truly said many times and in many ways that the foreman is the life blood, if not the mechanical department itself, to all intent and purposes.

If a higher official asks a master mechanic for a man to go to another division for promotion and he has none available, it is an admission on his part that he is not anticipating or planning for the future, and therefore that little can be expected from him as far as better results are concerned. He should be glad, if it were possible, to train men for the whole system and take pride in and profit by their success. It is worth while to be able to pick a winner and the best training obtainable is by teaching others.

The master mechanic dictates the policy of his shop, his subordinates execute it, therefore the most important item of all—choosing and making the subordinates—should be the master mechanic's particular duty. The general foreman should, of course, be consulted, but he should not select the men alone. This is a tedious operation requiring the highest skill, and the highest official, who is supposed to be the most skilled, should perform the task. Letting general foremen and roundhouse foremen select their subordinates invariably tends to stabilize or deteriorate the quality of the foremen, whereas if the higher official selects them, the quality should be persistently improved. From another angle, where various men handle this operation uniformity is not secured, while if the master mechanic selects them all, by and with the advice of his subordinates, uniform results will be obtained, mistakes in analysis can be more readily determined and guarded against.

As a concrete example the master mechanic says, "Mr. General Foreman, I want you to consult your subordinates, study and observe the workmen and give me the names of four men for prospective machine shop foremen, four for roundhouse foremen, two for boiler foremen and two for general foremen. I will then acquaint myself with these men in order to determine if they will prepare themselves, in anticipation of promotion. Give this matter mature thought for I will not approve your recommendations without personal investigation in each case and I am determined to have sufficient supervisory material in the making to fill all needs." A little talk with these men, after due deliberation and observation, should encourage them to make ready for promotion, and if their enthusiasm is aroused they will make good. Impress upon these men the required fundamentals, get them to thinking and planning and enthusing, tell them that their ability must grow if they expect it to bring more money each year, encourage them to consult with and study their superiors and invite them to attend a staff meeting from time to time. They can use their imagination and be acquiring skill as a supervisor so that there will be no question about their making good when their time for promotion comes.

John Mitchell.

NEW BOOKS

The Welding Encyclopedia. Compiled and edited by L. B. MacKenzie and H. S. Card, editors of the Welding Engineer, 336 pages, 6 in. by 9 in., illustrated. Bound in cloth. Published by the Welding Engineer Publishing Company, 608 South Dearborn street, Chicago.

The development of fusion welding processes and the rapid extension of their application in industry during the past decade has created a field which is now becoming highly specialized. Although several books have been published dealing with various phases of welding, the greater part of the literature on the subject is not available to the practical welder for the reason that it is widely scattered through periodical publications dealing primarily with other matters. The Welding Encyclopedia brings together in one volume a wide range of knowledge concerning welding practice, equipment and auxiliary appliances for all classes of work. About one-third of the subject matter is an illustrated definition section in which all words, terms, and trade names used in the welding trade are defined. Short treatises are included in this section on a number of the more important topics and it also serves as an index to the subject matter in the special chapters on the oxy-acetylene, electric arc, electric resistance and Thermit processes, the use and care of equipment, boiler welding, and the heat treatment of steels, which follow the definition section. A valuable feature of the book is the section on Rules and Regulations, which contains a compilation of the various codes of rules applying to fusion welding. These include the A. S. M. E. boiler code, the regulations of the Department of Commerce Steamboat Inspection Service, Lloyd's Register of Shipping, the Underwriters' Laboratory, the National Board of Fire Underwriters, the American Railway Association (M. C. B.), and the Interstate Commerce Commission specifications for gas shipping containers. The status of welding regulations in the various states is briefly summarized and where specific regulations have been developed these are given. There is also a catalogue section in which are described equipment, materials and supplies sold commercially for use in welding. The book forms a valuable reference work from which the practical welder may obtain much fundamental knowledge of correct practices for a wide range of work, and to which the general reader may refer for the meaning of terms and for a knowledge of the status of the different branches of the art.

Steam Locomotives of the Present Time (Die Dampflokomotiven der Gegenwart). By Robert Garbe, 7½ in. by 10½ in., illustrated. Volume 1, 859 pages; volume 2, 54 lithographed tables and drawings. Published by Julius Springer, Linkstrasse 23, Berlin W. 9, Germany.

This is a second edition of this well-known work originally published in 1907. The text has been brought up to date and an attempt has been made to present the same well-rounded survey of locomotive development in all countries that was given in the earlier work. Apparently the war interfered with the compilation of data and some parts of the book are unfortunately incomplete.

The book opens with an historical sketch of the use of highly superheated steam in locomotives and a discussion of the essential progress in locomotive building in the past 20 years. The first chapter deals with superheat as a working medium, the question being discussed largely from the theoretical viewpoint. The succeeding chapters are devoted to the calculation of the main dimensions of superheated steam locomotives, two-cylinder and multi-cylinder locomotives with simple and double expansion and the uniflow engine of which a rather extended discussion is given. Various types of superheaters are described and noteworthy structural details of more recent locomotives are discussed. A section is devoted to the latest developments in feed water heating. The superheated steam locomotives of the Prussian State Railways are described and the section following is devoted to superheated locomotives of various railroads in countries other than Germany. The American locomotives are described in this and in a previous chapter but the types shown cannot be classed as typical examples of the latest developments in motive power in this country. The results of numerous tests of superheated steam locomotives, principally in Germany, are set forth and it is notable that these are nearly all from seven to ten years old. The concluding chapters deal with details of design and operating methods.

Apparently the principal shortcoming of the book is the lack of complete and up-to-date information concerning the locomotives built by the allied countries. This, however, is not of primary importance as American readers would be chiefly interested in the book for the information they might obtain regarding the progress that has been made in Germany in the years during which communication was interrupted. Apparently the descriptions of German motive power have been given painstaking attention and the work of German designers during and since the war, is here presented for inspection for the first time.

In Boring Sheet Brass it is a good idea to place a piece of hard wood behind the piece being drilled.—*The Melting Pot.*

Delaware & Hudson Heavy Consolidation Locomotive

Notes on the Comparison of Locomotive Dimensions

Significance of the Principal Factors, Their Application in Designing and Values for Various Types

BY LAWFORD H. FRY

Standard Steel Works Co.

For a number of years past the Railway Mechanical Engineer has published lists of dimensions, weights and ratios in connection with the descriptions of new locomotives. It is felt that in view of the many new developments in recent years, the data furnished does not meet the present requirements. It has been decided to revise the form of tabulation hitherto used and in order that the new form should represent the best practice, suggestions have been invited from a number of authorities on locomotive design. The paper by Mr. Fry, presented below, is the first contribution on this subject. Others will appear in later issues.—EDITOR.

IN passing judgment on a locomotive design, attention must be given not only to the dimensions but to the proportion in which these stand to each other. These proportions are conveniently measured by the factors discussed below. Before entering the discussion it is well to note that the proportion between the dimensions is more conveniently expressed as a "factor" than as a "ratio." It must be remembered that a ratio must be expressed as the relation of one number to another and not as a single number. For example, if a locomotive with 202,000 lb. on drivers has a rated tractive effort of 45,000 lb. we may say that the ratio of adhesion is 4.1 to 1 or that the factor of adhesion is 4.1. The latter form of expression is the more convenient.

It is also convenient to give each factor a name and to designate each by a definite letter; thus (A) for the Factor of Adhesion, (B) for the Boiler Factor, and so on, as shown below.

Factors

The most important factors in common use are:

$$\text{A} = \text{Factor of Adhesion} = \frac{\text{adhesive weight}}{\text{rated tractive effort}}$$

$$\text{B} = \text{Boiler Factor} = \frac{\text{rated tractive effort}}{\text{evaporative heating surface}}$$

$$\text{C} = \text{Combustion Factor} = \frac{\text{evaporative heating surface}}{\text{grate area}}$$

$$\text{BD} = \text{Boiler Demand Factor} = \frac{\text{rated tractive effort} \times \text{driving wheel diameter}}{\text{evaporative heating surface}}$$

$$\text{E} = \text{Factor of Efficiency of Design} \quad \frac{\text{total weight}}{\text{evaporative heating surface}}$$

Sh/S = Superheater surface as percent of evaporative heating surface.

Before considering the factors in detail two of the dimensions entering into them require attention. These are the tractive effort and the heating surface. The rated tractive effort (R.T.E.) is computed from the well known formula R.T.E. $= \left(\frac{0.85 d^2 s P}{D}\right)$ where d is the cylinder diameter, s the stroke and D the driving wheel diameter, all in inches, while P is the boiler pressure in pounds per square inch. The force thus computed is the maximum tractive force deliverable by the cylinders at the rim of the drivers if the cut-off is long enough to give 92 per cent of the boiler pressure as mean effective pressure, and if the machine friction absorbs about 8 per cent of the indicated cylinder power (0.92 x 0.92 = 0.85 nearly). Even though these assumptions do not hold exactly, it is desirable to use the factor 0.85 in all cases so that the rated tractive effort is a definite measure of those dimensions of the cylinders, drivers and steam pressure which determine the tractive force.

The heating surface used in computing the factors is the total evaporative heating surface made up of the firebox, tube and flue heating surfaces, the superheating surface being left for separate consideration. Considerable use has been made of the so-called "equivalent heating surface" which is taken to be the evaporative surface plus 1.5 times the superheating surface. This is, however, a purely arbitrary figure and has little in its favor. The operation of a locomotive is primarily dependent on the steam produced by the evaporative surface. The addition of a certain amount of superheating surface enables the steam to work with greater efficiency and thus gives greater boiler power, but a continued increase in superheater surface would not give a continued increase in boiler power in the manner indicated by the "equivalent heating surface." To secure satisfactory comparisons for the steam producing capacity of the boiler and also for the added efficiency due to superheating, it is desirable to base the boiler factors on the evaporative surface and then to express the superheating surface as a percentage of the evaporative surface.

Table 1—Average Values of Various Factors for Different Locomotive Types

1	2	3	4	5	6	7	8	9	10
					$\frac{\text{Adhesive wt.}}{\text{Rated trac. effort}}$	$\frac{\text{Rated trac. effort}}{\text{Evap. heat. surf.}}$	$\frac{\text{Rated trac. eff.} \times \text{D}}{\text{Evap. heat. surf.}}$	$\frac{\text{Total weight}}{\text{Evap. heat. surf.}}$	Superheating Surface as % of Evap. heat. surf.
Reference to table of dimensions	Type	Steam.	Date	No. of locos.	A	B	BD	E	Sh/S
....	4-6-0	Sat.	1910	11	4.6	10.7	720	66	....
....	4-6-0	Suph.	1910	3	4.3	13.9	990	80	16.9
Table 2...	4-6-0	Suph.	1920	3	5.0	13.5	950	87	20.6
....	4-6-2	Sat.	1910	31	4.3	9.0	620	61	....
....	4-6-2	Suph.	1910	8	4.5	11.2	800	73	24.1
Table 3...	4-6-2	Suph.	1920	28	4.3	11.5	840	76	22.9
Table 4...	4-8-2	Suph	1920	10	4.3	12.6	860	80	23.5
....	2-8-0	Sat.	1910	21	4.3	13.7	800	66	....
Table 5...	2-8-0	Suph.	1920	16	4.1	17.8	1,015	82	21.4
Table 6...	2-8-2	Suph.	1920	28	4.1	14.1	870	75	22.8
Table 7...	2-10-2	Suph.	1920	12	4.2	15.0	920	78	24.0

Average values of the various factors are given in Table 1. These represent 161 locomotives of the types most in use at present for main line service. The values given under date of 1910 are taken from an earlier compilation made by the writer (The Engineer, Oct. 13, 1911), while those under date of 1920 are from Tables 2 to 7 herewith. The latter are all modern locomotives, the majority having been put into service between 1915 and 1920, and all use superheated steam.

Factor of Adhesion

$$A = \frac{\text{Adhesive Weight}}{\text{Rated Tractive Effort}}$$

The value of this factor shows the weight holding the wheels to the rail for each pound of average force tending to rotate them, and therefore measures the ability of the engine to start without slipping. In considering this it must be remembered that the force developed by the cylinders varies throughout the stroke, the value given by the formula for rated tractive effort being the average value, while the maximum value is about 20 per cent higher. With a clean dry rail slippage will not be likely to occur so long as this maximum value of the tractive force does not exceed 30 per cent of the weight on drivers, that is so long as the average value, the rated tractive effort, does not exceed 25 per cent of the weight on drivers. In other words, if A, the Factor of Adhesion, has a value of 4.0 or more the locomotive is not likely to be slippery on starting.

Column 6 of Table 1 shows average values of the factor A for various types of locomotives. It will be seen that the modern locomotives are quite uniform in having values from 4.1 to 4.3 on the average. The tendency is for the heavy drag types such as the 2-8-2 and 2-10-2 to have the lower values; that is, for these engines to have cylinders of a size to fully utilize all of the adhesive weight.

Boiler Factor

$$B = \frac{\text{Rated Tractive Effort}}{\text{Evaporative Heating Surface}}$$

This factor measures the pounds of rated tractive effort to be developed by each square foot of heating surface, when the engine is working in full gear. In the case of two locomotives at the same speed in miles per hour the horse-power of each is proportional to the tractive effort. (The formula is $\text{H.P.} = \frac{\text{T.V.}}{375}$, where V is the velocity in miles per hour.) Therefore under these conditions the horse-power required from each square foot of heating surface is proportional in each case to the value of the factor B. If one engine has $B = 10$ and the other $B = 12$ the latter is calling for 20 per cent more power from each square foot of heating surface.

It may be taken that at slow speeds with engines in full gear, a horse-power can be developed from 3.0 sq. ft. of heating surface in a saturated steam locomotive and from 2.5 sq. ft. in a superheated locomotive. On this basis the maximum speed in miles per hour at which the full rated tractive effort can be developed will be $V = \frac{125}{B}$ for saturated and $V = \frac{150}{B}$ for superheated locomotives.

Boiler Demand Factor

$$BD = \frac{\text{Rated Tractive Effort} \times \text{Driving Wheel Diameter}}{\text{Evaporative Heating Surface}}$$

This is simply the boiler factor B multiplied by the driving wheel diameter, D. With the engine in full gear, the factor BD is proportional to the foot-pounds of work done during each revolution for each square foot of heating surface. It is evident that both the B factor and the BD factor measure the relation between the cylinder and boiler dimensions, that is between the steam consuming and the steam producing parts of the locomotive. The difference between the two factors is shown in the following definitions:

When two locomotives are both developing their full rated tractive effort, or are both developing the same percentage of their rated tractive effort, the amount of horse-power to be supplied by each square foot of heating surface is proportional, for each locomotive, to the factor B when the speeds are the same in miles per hour, and is proportional to the factor BD when the speeds are the same in revolutions per minute. It is obvious that if two engines have the same driving wheel diameter, they will show the same relationship whether compared by their B or by their BD factors. The difference comes when two engines of the same type and designed for the same number of revolutions per minute are intended to work at different speeds in miles per hour and have driving wheel diameters in proportion to these working speeds. If both locomotives are well proportioned they will have approximately the same value of BD, while the slower speed engine will have a correspondingly larger value of B. The BD factor is therefore a better measure of the basic proportions of the locomotive.

Values of the factors B and BD from columns 7 and 8 of Table 1 show the following average values for modern superheater locomotives:

Type	B	BD	D
4–6–2	11.5	840	73 in.
4–8–2	12.6	860	68 in.
2–8–2	14.1	870	62 in.
2–10–2	15.0	920	62 in.
2–8–0	17.8	1015	57 in.

These figures show that the 4-6-2, 4-8-2 and 2-8-2 types have very similar values of BD, the averages running from 840 to 870, while the values of the factor B increase as the driving wheel diameter is decreased. With the 2-10-2 and 2-8-0 types the tractive power stands in a larger proportion to the heating surface, as shown by the larger values of BD. The fact of course is, that these types having a large proportion of their weight on driving wheels, offer more opportunity for providing large cylinders and less for providing heating surface. The larger values of *BD* show that they are adapted for lower speeds in revolutions per minute, while the proportionately still larger values of *B* (due to smaller driver diameters) indicate considerably lower speeds in miles per hour.

For a comparison between saturated and superheated steam the following figures are taken from Table 1 for the Pacific type (4-6-2) and the Consolidation (2-8-0) which are the only two classes appearing in the older saturated class and also among the more modern superheaters.

	B	BD	D
4-6-2 Superheated	11.5	860	73 in.
4-6-2 Saturated	9.0	620	69 in.
Difference as percent of value for superheated engine	22 per cent	28 per cent	
2-8-0 Superheated	17.8	1015	57 in.
2-8-0 Saturated	13.7	800	58 in.
Difference as percent of value for superheated engine	23 per cent	21 per cent	

The indication is that when saturated steam is used the boiler

FACTORS FOR INDIVIDUAL LOCOMOTIVES OF VARIOUS TYPES

TABLE 2—TEN WHEEL TYPE, 4-6-0

Road	Total weight Lb. Wt.	Adhesive weight Lb. Wa.	Cylinder diameter and stroke In. dxs	Driving wheel diameter In. D	Boiler pressure Lb. sq. in. P	Rated tractive effort Lb. T	Evaporative heating surface Sq. ft. S	Grate area Sq. ft. R	Superheating surface Sq. ft. Sh	Adhesive wt. / Rat. trac. eff. A	Rat. trac. eff. / Evap. surf. B	Evap. heat. surf. / Grate area C	R. T. E. x D. / Evap. heat. surf. BD	Total weight / Evap. heat. surf. E	Superheating surf. as per cent of evap. surf. Sh/S
St. L. S. W.	209,400	165,200	22x28	69	185	33,400	2,474	49.6	532	5.0	13.5	49.8	930	84.8	21.6
Ga. S. & F.	192,300	147,200	21x28	68	200	31,000	2,268	49.0	462	4.8	13.6	46.4	980	85.0	20.4
Cen. Ver.	189,000	141,000	20x28	69	200	27,600	2,053	53.4	404	5.1	13.5	38.5	930	92.5	19.7
Average	197,000	151,000	.....	69	195	31,700	2,270	....	466	5.0	13.5	....	946	87.4	20.6

TABLE 3—PACIFIC TYPE, 4-6-2

L. V.	311,900	204,600	27x28	73	205	48,600	4,116	95.21	980	4.2	11.8	43.3	860	71.3	23.6
P. R. R.*	308,900	201,800	27x28	80	205	44,500	4,035	70.0	1,155	4.5	11.0	57.5	880	76.5	28.7
Erie	306,000	197,000	27x28	79	200	43,800	3,824	70.8	880	4.5	11.4	55.5	905	78.0	22.5
D. L. & W.	305,500	192,200	27x28	73	200	47,500	3,680	91.3	760	4.1	12.9	40.3	940	83.0	20.7
Pa. Lines	302,000	193,000	26x26	80	205	38,250	3,680	55.4	845	5.1	10.4	76.5	830	82.0	23.0
L. V.	301,500	192,200	27x28	73	205	48,800	4,103	75.0	980	3.9	11.9	54.8	870	73.5	23.9
A. T. & S. F.	300,950	180,000	25x28	73	200	40,800	4,110	66.5	942	4.4	9.9	62.0	725	73.1	22.9
St. L. S. F.	296,000	191,000	26½x28	73	200	45,800	4,200	63.5	996	4.2	10.9	66.2	795	70.5	23.8
R. F. & P.	293,000	188,000	26x28	68	200	47,300	4,205	66.7	975	4.0	11.2	63.0	765	69.6	23.2
C. R. R. N. J.	291,400	181,400	26x28	79	210	42,800	3,757	94.8	816	4.2	11.4	39.8	900	78.2	21.6
Monon	285,000	179,000	26x28	73	190	41,900	4,048	62.6	935	4.3	10.3	64.4	755	70.5	23.1
C. C. & O.	283,000	177,000	25x30	69	200	46,000	3,982	53.8	955	3.8	11.6	74.2	800	70.5	24.0
†B. & O.	275,800	167,000	25x28	73	200	40,700	3,341	66.7	794	4.1	12.2	50.0	890	83.0	23.8
T. & P.	275,100	173,400	26x28	73	185	40,900	3,780	59.6	844	4.3	10.8	63.4	790	72.8	22.3
M. K. T.	272,000	165,000	25x28	73	200	40,700	3,838	57.5	870	4.0	10.6	67.0	770	71.0	22.7
N. Y. C.	269,400	171,300	23½x26	79	200	30,900	3,427	56.5	803	5.6	11.1	60.6	875	78.5	23.4
C. B. & Q.	269,200	171,300	27x28	74	180	42,200	3,364	58.7	751	4.1	12.5	57.5	930	80.0	21.3
N. Y. N. H. & H.	266,000	165,000	26x28	79	200	40,800	3,315	59.2	776	4.0	12.3	56.0	970	80.5	22.7
C. G. W.	257,000	152,400	25x28	73	190	38,700	3,732	56.0	794	3.9	10.4	66.8	755	69.0	21.3
G. N. R.	251,200	150,700	23½x30	73	210	40,500	3,076	53.3	640	3.5	13.2	57.8	960	82.0	20.8
N. & W.	249,300	163,900	22½x28	70	200	34,400	3,359	44.7	756	4.8	10.2	75.0	720	74.0	22.6
N. Y. N. H. & H.	246,200	153,100	24x28	79	200	34,800	3,355	53.5	730	4.4	10.4	63.0	820	73.5	21.8
A. C. L.	243,900	151,000	23x28	68	200	37,000	3,345	56.5	792	4.1	11.0	59.2	750	73.0	23.7
C. of Ga.	228,600	138,000	23x28	69	190	34,700	2,689	50 6	605	4.0	12.9	53.0	890	85.0	27.5
G. T. R.	224,000	146,700	23x28	69	185	33,800	2,826	50.6	592	4.3	12.0	55.9	825	79.4	21.0
N. C. & St. L.	219.550	143,500	23x28	69	185	33,800	2,891	52.4	592	4.3	11.8	55.2	805	75.8	20.8
N. O. & N. E.	206,700	130,500	22x28	68	200	33,900	2,573	46.0	546	3.9	13.2	56.0	900	80.5	21.2
M. R. & B. T.	190.500	123,400	21x26	64	190	29,000	2,417	44.3	558	4.3	12.0	54.5	765	79.0	23.0
Average	268,000	169,000	.....	73	197	40,300	3,540	....	810	4.3	11.5	....	835	76.0	22.9

*U. S. R. A., 4-6-2 B. †U. S. R. A., 4-6-2 A.

TABLE 4—MOUNTAIN TYPE, 4-8-2

A. T. & S. F.	367,700	243,100	28x28	69	200	54,100	4,802	71.5	1,086	4.5	11.3	67.1	780	76.5	22.6
*C. & O.	352,000	243,000	28x30	69	200	58,000	4,662	76.3	1,078	4.3	12.2	61.1	843	75.5	23.2
N. Y. C.	343,000	234,000	28x28	69	185	50,000	4,430	66.8	1,212	4.7	11.3	66.2	780	77.5	27.4
N. & W.	341,000	236,000	29x28	70	200	57,200	3,984	80.3	882	4.1	14.3	49.5	1,010	85.5	22.1
R. I.	337,000	224,000	28x28	69	185	50,000	4,117	62.7	944	4.5	12.1	65.8	840	61.0	22.9
*S. Ry.	327,000	224,500	27x30	69	200	53,900	4,121	70.8	957	4.2	13.1	58.3	905	79.3	23.2
G. N. R.	326,000	218,000	28x32	62	180	61,900	4,540	78.0	1,075	3.5	13.6	58.1	840	72.0	23.7
S. A. L.	316,000	210,500	27x28	69	190	47,800	3,715	66.7	865	4.4	12.9	55.6	890	85.0	23.3
So. Ry.	314,800	209,800	27x28	69	190	47,800	3,668	66.7	942	4.4	13.0	55.0	900	85.5	25.7
C. P. R.	286,000	192,000	23½x32	70	200	42,900	3,667	59.6	760	4.5	11.7	61.5	615	78.0	80.7
Average	330,700	223,500	.....	69	193	52,400	4,170	....	980	4.3	12.6	....	860	79.6	23.5

*U. S. R. A., 4-8-2-B. †U. S. R. A., 4-8-2-A.

TYPE 5—CONSOLIDATION TYPE, 2-8-0

D. & H.	293,000	267,500	27x32	63	195	61,400	3,814	99.8	793	4.3	16.1	38.2	1,120	88.2	21.8
L. S. & I.	268,000	238,000	26x30	57	185	55,900	3,643	57.7	844	4.2	15.3	63.1	870	73.5	23.2
W. & L. E.	266,500	236,000	26x30	57	185	55,900	3,517	66.8	774	4.2	15.9	52.7	905	76.0	22.0
Pa. Lines	249,500	226,900	26x28	62	205	53,000	3,016	55.0	623	4.3	17.6	54.8	1,090	83.0	20.7
D. T. & I.	245,000	220,000	25x30	52	200	61,300	3,302	61.3	723	3.6	18.5	54.0	965	74.0	21.9
W. Md.	244,500	217,500	25x30	51	200	62,500	3,148	61.3	594	3.5	19.8	51.5	1,020	77.8	18.8
K. & M.	239,500	209,500	25x30	57	180	50,400	3,153	55.0	633	4.1	16.0	57.5	910	76.0	20.0
Interstate	222,600	192,200	25x32	61	180	50.000	2,951	54.0	646	3.8	17.0	54.6	1,035	75.5	21.9
B. & M.	211,000	186.000	24x30	61	180	43,400	2,392	53.4	522	4.3	18.3	45.0	1,120	88.2	21.8
Toledo Ter.	198,000	176,000	22x28	51	175	39,500	2,425	54.5	499	4.4	16.3	44.5	830	81.5	20.9
St. L. S. W.	232,800	202,300	25x30	61	190	49,600	2,800	52.5	591	4.1	17.7	53.4	1,080	83.0	21.2
D. & T. S. L.	215,200	190,000	23x30	63	180	38.500	2,355	50.6	450	5.0	16.4	46.5	1,030	91.0	19.1
S. & N. Y.	212,900	195.400	23x28	51	185	45,500	2,726	49.5	626	4.3	16.6	55.4	850	77.9	22.8
C. & C.	198,800	176,000	23x28	52	190	46,000	2,473	52.3	526	3.8	18.6	49.2	970	80.5	21.3
P. & R.	281,100	250.800	25x32	55½	200	61,260	2,655	94.9	575	4.1	23.0	27.0	1,280	94.5	21.6
Union	260.300	240.300	25x32	55	190	58,700	2.771	54.4	654	4.1	21.2	51.0	1,170	94.0	23.6
Average	240,000	202,000	.....	57	189	52,000	2,950	....	625	4.1	17 8	....	1,015	82.1	21.4

factors should be 20 to 25 per cent lower than with superheated steam.

Combustion Factor

$$C = \frac{\text{Heating Surface}}{\text{Grate Area}}$$

The value to be given this factor is determined by the quality of the fuel to be used. For this reason no averages have been struck, as there is no meaning in an average based on varying grades of fuel. The individual figures show that the roads using anthracite aim at having a value of about 35 to 40, while the soft coal roads aim at about 55 to 60, for superheater locomotives. In saturated steam locomotives the necessity for greater heating surface tends to increase these figures from 10 to 20 per cent.

Factor of Efficiency of Design

$$E = \frac{\text{Total Weight}}{\text{Heating Surface}}$$

This gives the pounds of total weight per square foot of heating surface. Strictly speaking, this factor is an inverse measure of the efficiency of design, for the larger the factor the greater the weight the designer has required to secure the heating surface which is the source of power.

Values taken from Table 1 show average values for modern superheater locomotives as given herewith.

	Factor E
4-6-2	76
4-8-2	80
2-8-2	75
2-10-2	78
2-8-0	82

For saturated steam locomotives the values will be increased by from 15 to 20 per cent.

Superheater Surface as a Percentage of Evaporative Heating Surface

The meaning and value of this factor require little explanation. It is evident from Table 1 that the average value for all types is very close to 23 per cent, and it will be seen in the other tables that the variation of the individual values from the average is considerably less than for the other factors. This is natural as the same amount of superheat is desired irrespective of the locomotive type. The uniformity is also partly due to the design of the superheaters being largely in the hands of a single concern.

Use of Factors in Design

The factors which have been discussed afford a complete basis for a preliminary estimate of the general dimensions of a locomotive to fulfill any given conditions of service. Take for example the following problem:

Required the general dimensions of a Pacific type locomotive, to have drivers 70 in. in diam., to burn bituminous coal, and to be capable of developing a running tractive effort of 17,750 lb. at the rim of the drivers, at a speed of 40 miles per hour.

This means that $\frac{17{,}750 \times 40}{375} = 2{,}000$ horse-power must be developed. Assuming that 1.7 sq. ft. of heating surface are required for each horse-power, we find that 3,400 sq. ft. are required for 2,000 horse-power. The remaining dimensions follow at once if the various factors are given the average values taken from Table 1, viz.:

$$A = \frac{\text{Wt. on drivers}}{\text{Rated Tract. Effort}} = 4.3$$

$$BD = \frac{\text{Rated Tract. Eff.} \times \text{Dr. diam.}}{\text{Heating surface}} = 840$$

$$C = \frac{\text{Heating Surface}}{\text{Grate Area}} = 55$$

$$E = \frac{\text{Total Weight}}{\text{Heating Surface}} = 76$$

Superheater Surface = 23 per cent of Heating Surface.

The results obtained are:

Total Weight	258,000 lb.
Wt. on Drivers	176,000 lb.
Rated Tract. Eff.	40,800 lb.
Heating Surface	3,400 sq. ft.
Superheater Surface	780 sq. ft.
Grate Area	60 sq. ft.

A preliminary lay-out of the general dimensions in this way is of great use to the designer, or in consideration of new power. It is of course to be understood that the dimensions correspond to average values and can be modified to suit the details of design and service.

Other Factors

There has been a practice of using some other factors for the same purpose as those discussed above. An examination of them will show, however, that they merely duplicate the information given by the preceding factors and throw no additional light on the proportions or performance of the locomotive. Among these factors are the following:

Total Weight Divided by Tractive Effort.—This is not an important comparison to make, as the connection between total weight and tractive effort is only secondary. The tractive effort has a direct connection with the weight on drivers which provides adhesion, and again with the heating surface which furnishes the steam. The total weight has a direct connection with the heating surface, as it represents the expenditure necessary to obtain the steam production. The relation of tractive power to total weight is indirect, the factor connecting them depending first, on the heating surface provided for the tractive effort which is governed by the speed required, and second, on the total weight required to provide each unit of heating surface, which is governed by the methods of the designer. It, therefore, follows that a comparison based on the relation between total weight and tractive effort is meaningless unless we know the relation between tractive effort and heating surface, and also that between heating surface and total weight. These latter relations are measured respectively by the factors *B* and *E*, and if they are known we gain nothing by computing a factor to show the relation between total weight and tractive effort.

Weight on Drivers Divided by Heating Surface.—This again is a secondary relation which has no meaning unless we know the relation between weight on drivers and tractive effort (factor *A*) and the relation between tractive effort and heating surface (factor *B*). When these two relations are known our useful knowledge is not increased by finding the combined relation between the weight on drivers and the heating surface.

Cylinder Volume in Relation to Heating Surface.—The volume of steam used per revolution at a given cut-off is proportional to the volume of the cylinders. Consequently the relation of the cylinder volume to the heating surface may be taken as a measure of the relation of steam requirement to steam supply. So long as the boiler pressure is the same, the comparison will be similar to that obtained from the *BD* factor. The cylinder volume relation, however, takes no account of the boiler pressure, and consequently in the case of two similar locomotives one with 160 and the other with 200 lb. per sq. in. boiler pressure, it would show no difference in the relation of steam consumption to steam production. Actually, although the volume of steam used is the same for both, the weight of the steam is approximately 21 percent greater for the locomotive with 200 lb. per sq. in. boiler pressure. The *BD* factor brings the boiler pressure into account, and shows the effect of the greater steam consumption and greater power due to higher boiler pressure. Comparisons made on the basis of the *BD* factor are therefore more representative of actual conditions than those made on the basis of cylinder volume.

Table of Dimensions of Modern Locomotives

Tables 2 to 7 give for 97 modern superheater locomotives, particulars of the general dimensions and of factors based on these dimensions. The average values of the factors for modern locomotives which are given in Table 1 are drawn from these tables. The individual figures need no further comment, but are of interest, both as giving the actual sizes of the locomotives, and as showing the deviations of the individual values of the factors from the average values.

TABLE 6—MIKADO TYPE, 2-8-2

Road	Total weight Lb. Wt.	Adhesive weight Lb. Wa.	Cylinder diameter and stroke In. dxs	Driving wheel diameter In. D	Boiler pressure Lb. sq. in. P	Rated tractive effort Lb. T	Evaporative heating surface Sq. ft. S	Grate area Sq. ft. R	Superheating surface Sq. ft. Sh	Adhesive wt. / Rat. trac. eff. A	Rat trac. eff. / Evap. surf. B	Evap. heat. surf. / Grate area C	R. T. E. x D / Evap. heat. surf. BD	Total weight / Evap. heat. surf. E	Superheating surf., as per cent of evap. surf. Sh/S
P. & R.	329,300	246,600	24x32	61½	225	57,320	4,224	108.0	993	4.3	13.5	39.2	835	78.0	23.5
L. V.	325,200	232,000	27x30	63	190	57,000	4,150	100.0	980	4.2	13.7	41.5	865	78.5	23.6
A. T. & S. F.	322,900	240,300	27x32	63	190	59,800	4,626	66.8	1,086	4.0	12.9	69.5	815	70.0	23.5
E. P. & S. W.	321,000	242,000	29x30	63	176	59,900	4,230	70.3	1,030	4.0	14.1	60.2	890	76.0	24.4
*P. & L. N.	320,000	239,000	27x32	63	190	60,000	4,285	70.3	993	4.0	14.0	61.0	885	74.5	23.2
C. P. R.	320,000	235,000	25x32	63	200	54,150	3,665	70.3	845	4.2	15.3	52.3	960	87.5	23.0
P. B. R.	319,300	236,900	27x30	62	205	61,500	4.035	70.0	1,154	3.9	15.2	57.6	975	79.2	28.7
C. B. & Q.	315,000	239.200	28x32	64	180	60,000	4,465	78.0	1,005	4.0	13.4	57.4	860	70.5	22.4
P. R. R.	314,600	237,500	27x30	62	205	61,500	4,058	70.0	962	3.9	15.2	58.2	975	77.5	23.6
M. K. & T.	314,000	233.500	28x30	61	185	50,600	4.341	62.7	1,025	3.9	14.0	69.1	855	72.5	23.7
C. C. & O.	311,400	230,000	27x30	63	190	56,000	4,117	78.0	933	4.1	13.6	53.0	860	75.5	22.6
N. Y., N. H. & H.	309,500	241,000	26x32	63	200	58,400	3,864	59.2	870	4.1	15.1	65.4	950	80.0	22.5
G. N. R.	306,500	229,000	26x32	63	180	60,930	4,665	78.0	918	3.8	13.0	59.8	820	65.8	19.6
I. & N.	302,000	236,000	27x30	60	185	57,000	3,943	58.0	922	4.1	14.5	68.0	870	76.5	22.5
Va. Ry.	297,500	229,600	26x32	56	185	60,500	4,359	57.0	910	3.8	13.9	76.5	775	68.4	20.5
Montour	296,500	249,500	27x32	57	185	64,500	3,892	66.7	836	3.9	16.5	58.2	945	76.4	21.5
I. C. R.	293,900	226.800	27x30	63	175	51,630	4,106	70.4	887	4.4	12.5	58.5	790	71.5	21.6
†B. & O.	290,800	221,500	26x30	63	200	54,600	3,777	66.7	945	4.1	14.5	56.5	910	77.0	25.0
C. G. W.	285,900	221,500	27x30	63	187	55,000	3,759	67.7	798	4.0	14.6	55.5	920	76.1	21.2
U. P.	282,800	219,400	26x28	63	200	51,100	4,216	70.0	912	4.3	12.4	60.2	780	67.2	21.6
S. A. L.	282,000	207,500	27x30	63	170	50,200	3,537	63.2	759	4.1	14.2	56.2	880	80.0	21.4
B. & O.	281,900	222,100	26x32	64	190	54.600	3,970	70.0	882	4.1	13.8	57.0	880	71.0	22.2
S. P.	280,960	214,000	26x28	63	200	51,000	4,215	70.4	890	4.2	12.1	60.0	760	66.8	21.1
A. C. L.	280,700	223,200	27x30	63	200	59,000	3.306	73.4	742	3.8	17.8	52.5	1,120	85.0	22.4
C. B. & Q.	278,600	211,300	27x30	64	180	52,200	3,364	58.7	751	4.1	15.5	57.4	995	83.0	22.3
N. C. & St. L.	272,700	215,800	25x30	58	180	49,500	3,804	66.6	840	4.4	13.0	55.5	755	73.8	22.6
Mo O. & G.	232,000	177,100	23x28	52	180	43,600	3,778	57.2	838	4.1	11.5	66.0	600	61.4	22.2
V. S. & P.	217,500	168,400	22x28	57	200	40,400	2,573	46.0	546	4.2	15.7	56.0	895	84.6	21.2
Average	292,000	226,000	......	61½	190	56,900	3,980	....	900	4.1	14.1	....	870	75.0	22.8

*U. S. R. A. 2-8-2-B. †U. S. R. A. 2-8-2-A.

TABLE 7—SANTA FE TYPE, 2-10-2

Road	Total weight Lb. Wt.	Adhesive weight Lb. Wa.	Cylinder diameter and stroke In. dxs	Driving wheel diameter In. D	Boiler pressure Lb. sq. in. P	Rated tractive effort Lb. T	Evaporative heating surface Sq. ft. S	Grate area Sq. ft. R	Superheating surface Sq. ft. Sh	Adhesive wt. / Rat. trac. eff. A	Rat trac. eff. / Evap. surf. B	Evap. heat. surf. / Grate area C	R. T. E. x D / Evap. heat. surf. BD	Total weight / Evap. heat. surf. E	Superheating surf., as per cent of evap. surf. Sh/S
D. R. G.	428,500	337,500	31x32	63	195	81,200	5,369	88.0	1,329	4.2	15.1	61.0	950	79.5	24.8
Erie	417,200	337,400	31x32	63	200	83,000	5,863	88.0	1,389	4.5	14.2	66.6	890	71.3	23.7
B. & O.	406,000	336,800	30x32	58	200	84,500	5.573	88.0	1,329	3.9	15.2	63.5	880	73.0	23.8
B. & L. E.	404,250	332,700	30x32	60	200	81,600	5,191	88.0	1,237	4.0	15.7	59.0	945	77.8	23.8
Erie	401,000	335,500	31x32	63	200	83,000	4.959	94.8	1,274	4.0	16.7	52.5	1,050	81.0	25.7
Wabash	395,000	314,000	29x32	64	195	69,700	5,370	80.2	1,129	4.5	13.0	67.0	830	73.5	21.0
R. I.	383,000	302,500	30x32	63	185	71,900	4,608	80.2	1,180	4.2	15.5	57.5	980	83.0	25.6
St. L., I. M, & S.	370,000	294,500	30x30	63	186	72,500	4,617	80.3	1,170	4.1	15.6	57.5	985	80.0	25.4
C. B. & Q.	370,000	293,000	30x32	60	175	71,500	5,349	88.0	1,232	4.1	13.3	61.0	800	69.0	23.0
N. Y. O. & W.	352,500	293,000	28x32	57	190	71,200	4,498	80.0	1,007	4.1	15.8	56.5	900	78.5	22.2
C. I. & L.	341,000	275,500	28x30	57	190	66,700	4,761	70.0	1,235	4.1	14.0	68.0	800	71.8	26.0
T. & P.	324,600	262,100	28x32	63	165	62,600	3,846	70.0	886	4.2	16.3	55.0	1,025	84.5	23.6
Average	382,000	310,000	......	61	192	75,000	5,000	....	1,200	4.2	15.0	....	920	78.0	24.0

Stoker Fired Locomotive Makes Continuous Run Over Three Divisions

To demonstrate the fact that a trip for a locomotive need not necessarily be limited to one division of approximately 100 miles as has been generally the fixed practice on railroads for many years past, the Erie Railroad recently planned a test run by which one of its through New York-Chicago passenger trains would be hauled over three divisions, by one engine alone instead of using three engines for the three divisions as is the practice at the present time.

This test was based on the belief that the superior firing service of the modern mechanical stoker on heavy locomotives and long runs would render fire cleaning unnecessary at the end of each division. Continuous operation over the three divisions would be advantageous as it would eliminate the costs of terminal handling, such as changing engines, cleaning fires, coaling, turn table and roundhouse service, time consumed, etc. It was believed these charges could be divided by three.

Accordingly on February 24, heavy Pacific type engine No. 2926 equipped with a Duplex stoker attached to Erie train No. 3, consisting of one mail car, one express car, two coaches, two Pullman cars and one dining car left Jersey City at 12.18 p. m., for a continuous trip over the New York, Delaware and Susquehanna divisions, a total distance of 332.3 miles. The train arrived at Hornell, the final terminal at 11.28 p. m. on time, having covered this distance without incident in 9 hours and 13 minutes.

On the return trip, February 25, the same engine left Hornell at 10.57 a. m., one hour and one minute late, with train No. 4 consisting of one mail car, one express car, two coaches, two Pullman cars and one dining car, arriving at Jersey City at 7.00 p. m. on time. There was no hand firing done nor was the rake used during the round trip of 664.6 miles.

The fire was clean on arrival at Jersey City terminal, the ash pan being reasonably free from ash and not in any way clogged; and insofar as the condition of the engine was concerned, it could have been placed on another train and returned to Susquehanna over two divisions, a distance of 192 miles. This trip demonstrated decisively the practicability of one engine covering three divisions, and this was only made possible by this Pacific type engine being mechanically fired.

Design of an Improved Locomotive Throttle Valve

New Type Developed on Buffalo, Rochester and Pittsburgh, Has Many Advantages for Large Power

BY W. J. KNOX
Mechanical Engineer, Buffalo, Rochester and Pittsburgh

THE mounting cost of labor and materials, the lack of money with which to provide terminal facilities and to increase rolling stock have all made insistent demands for more intensive operation and more refined and economical appliances and methods. Every department of the railroads has labored to better operation. The mechanical department, with the others, has made earnest efforts in this direction and while there have been very few radical or basic improvements in the steam locomotive for some years, there has been a constant and steady rejuvenation and improvement of old and existing appliances and methods, and a constant development of new ones. Many of these aim at fuel saving through numberless channels, some at labor saving, others to promote safety and security, all with the common desire to improve economy and increase capacity. One of the steps recently accomplished in this direction by the mechanical department of the Buffalo, Rochester & Pittsburgh is described in the following.

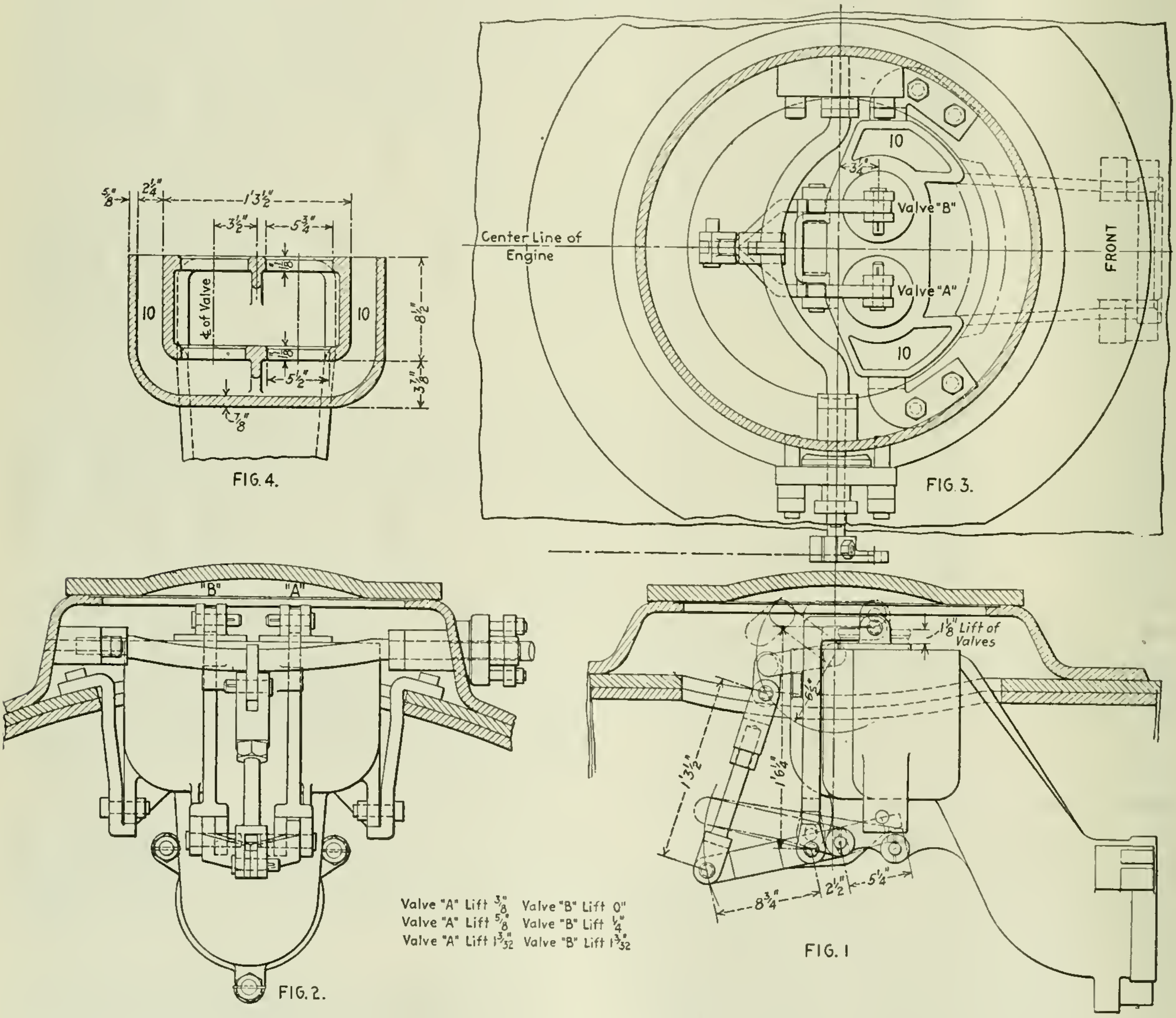


FIG. 4.

FIG. 3.

FIG. 2.

Valve "A" Lift 3/8" Valve "B" Lift 0"
Valve "A" Lift 5/8" Valve "B" Lift 1/4"
Valve "A" Lift 1 3/32" Valve "B" Lift 1 3/32"

FIG. 1

General Arrangement of Throttle Valve

Problem of the Throttle Valve

For locomotives of maximum capacity to generate sufficient steam, the boiler must be extremely large. The limitations of clearances so restrict the height of the dome that the throttle standpipe is quite short and the distance above the water level, with three gages of water, to the steam admission level is small. To prevent priming it is essential, therefore, that steam be admitted to the throttle on these large engines at as high a level as possible.

In American practice, the throttle valve is almost invariably a single valve of the poppet type, generally arranged for double admission with two seats or with single admission and a dash pot or piston to balance the single valve. In either case, especially when of the single admission form, to provide sufficient passageway without excess lift the valve must be very large in diameter and of great weight. If of the double admission type, it is difficult to so balance the valve that it can be operated without resorting to much compounding of the leverage and long travel of the throttle lever, or the pull required at the lever handle must be very great. Valves of the single admission type with balancing pistons, while more easily operated, have developed numerous faults in service.

The valves are cold when ground in and even though the work is well done and tested before steam is raised in the boiler, the large disc, when heated to the temperature of the steam at working pressure, becomes distorted and the valve cannot be kept tight. A further objection to the valve of large diameter is that when the engine is working light and a limited steam supply is admitted to the dry pipe, the large valve will be opened a mere crack. This results in wire drawing the steam between the joint face of the valve and seat, quickly cutting these joint faces and causing the valve to leak.

Leaking throttle valves have always been a source of trouble, annoyance and much waste of fuel, but with the introduction of the superheater other causes of fuel waste, shop expense and danger have been introduced, not before so apparent. When working with a throttle design permitting admission of steam at a low level much priming results and the superheater units must serve to evaporate the excess moisture, consequently reducing the resulting temperature and efficiency. From a leaking throttle and the results of evaporation in the units, courses of scale are built up in the header at the discharge ends of the units until the openings are almost or entirely closed. This prevents or retards circulation and the ends of the units next the fire become heated, are swelled spherically by the pressure and burst, a real source of danger and very expensive to repair. This is not a hypothetical case, but happens repeatedly after a few months' service, and the trouble has been cured or at least greatly improved by using the design illustrated.

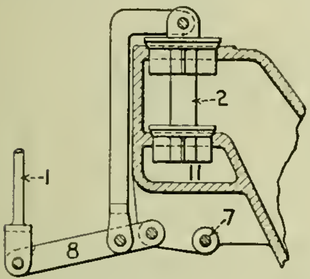


Fig. 5

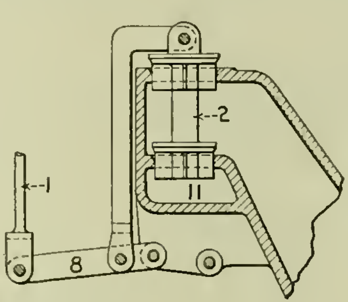


Fig. 7
Operation of Valve "A"

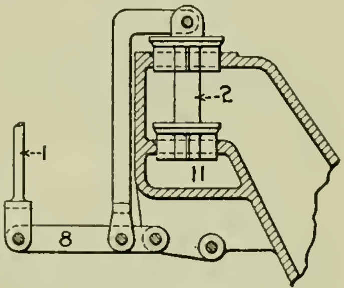


Fig. 9

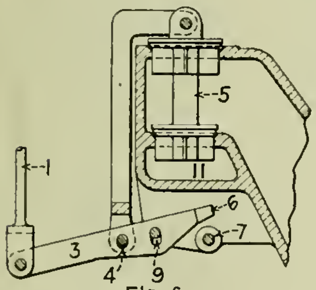


Fig. 6

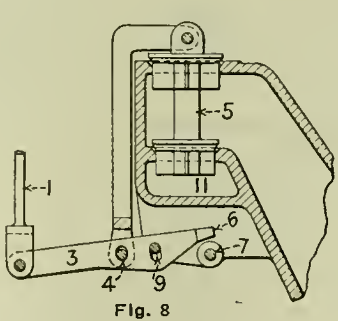


Fig. 8
Operation of Valve "B"

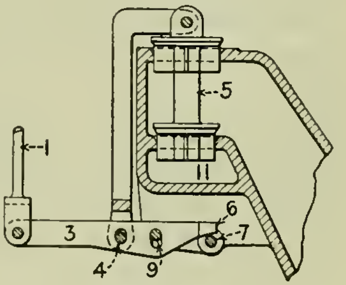


Fig. 10

Details of the Operating Mechanism

Operation of the Improved Valve

In the operation of the throttle valve the upward movement of the connecting rod, 1, from the position indicated in Fig. 5 first moves the valve member, 2, as shown in Fig. 7 and at the same time moves the lever, 3, to the position of Fig. 8, thus taking up the lost motion in the elongated pivot opening, 4, without causing any movement of the valve member, 5. A further upward movement of the connecting rod, 1, brings the parts to the positions indicated in Figs. 9 and 10, the valve member, 2, being opened still farther and the opening movement of the valve member, 5, starting. The lever, 3, is now moved so that its end, 6, engages the transverse rod, 7, this rod constituting the fulcrum for the lever during its further movement.

As the connecting rod is moved upward still further the valve members are opened simultaneously, the opening movement of the member 5 being more rapid due to the fact that the right hand end of the lever arm, 3, is longer than the corresponding end of the lever arm, 8. This movement of the lever arm, 3, is permitted by reason of the clearance in the elongated pivot opening, 9. At full travel both valves are open an equal amount. All the steam passing the throttle valve is admitted at the highest point possible, at the top level of the pipe. For the top seats the steam enters directly from the dome at the level of the seats. For admission through the bottom seats, steam is supplied by the ports, 10, to chamber, 11, below the valves as shown in the general arrangement, Figs. 3 and 4.

The opening provided by one valve before the second commences to lift is ample to pass the steam required by the locomotive when working light and can be graduated to meet the requirements when drifting much better than by so-called drifting throttles and special drifting appliances. The two valves are each one-half the diameter of a single valve and as they are arranged to open in sequence the lifting force required is only sufficient to overcome the unbalanced area of one small valve or is only one-half as much as for the large valve. The two small valves weigh less than the single large valve. The small valves are more easily machined, are much easier to grind in and experience has shown that they are tight when first applied and remain tight in service. Frequent regrinding is not necessary.

Advantages of the New Design

Among other advantages claimed for this design of throttle valve is the fact that the waste from escaping steam is avoided and the danger from the locomotive moving, if not blocked, does not exist. Scale does not build up in the header, stop up the discharge openings from the units and prevent circulation. The danger from bursting and leaking superheater units is reduced to a minimum.

The heavy expense and lost time incident to taking out the units and welding or applying new return bends is thus avoided and the efficiency of the superheater is not impaired. Most important of all, the locomotive is not held out of service so frequently and is in safe condition to handle traffic economically.

A New Rod Design

In April, 1917, the Erie applied main and side rods of an unusual design as shown in the accompanying drawing to a ten-wheel locomotive which has since been operating out of Jersey City in heavy suburban passenger service. The change in design was accomplished by lengthening the main crank pin to accommodate the back connecting rod bushing outside of the main rod bushing. The crank pin on the rear driver was lengthened to correspond with the main pin and the cross section considerably increased to withstand the additional stress.

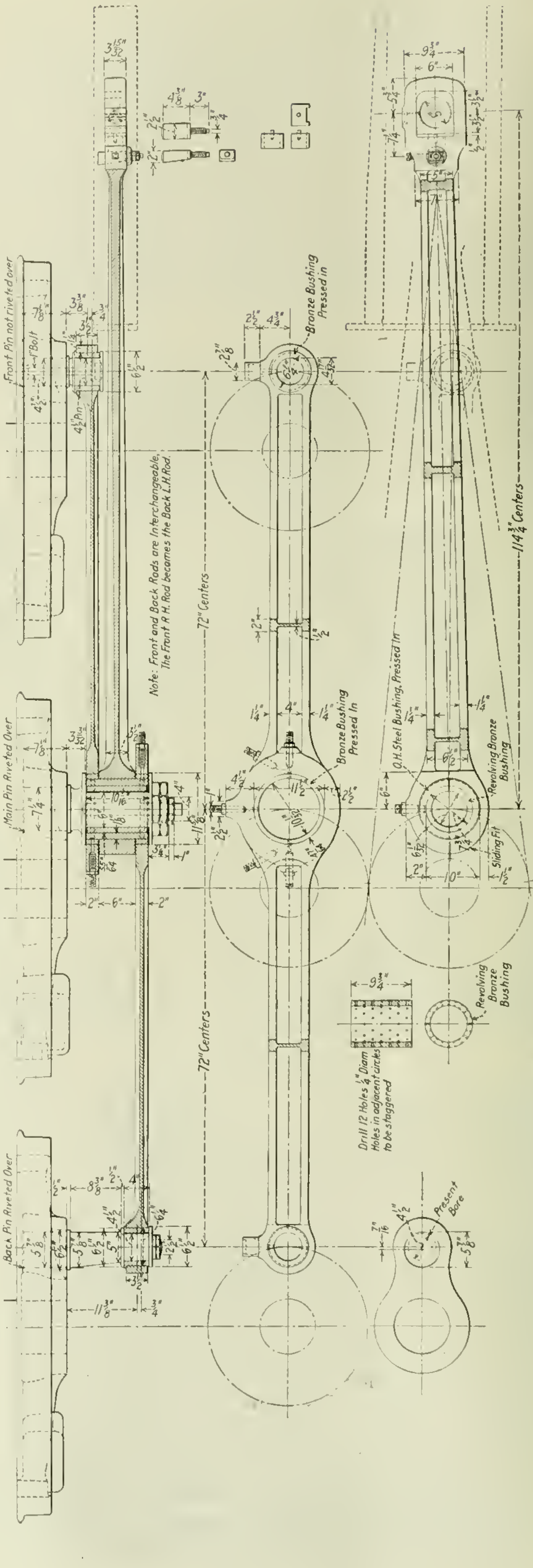
As will be observed in the drawing, this arrangement at once eliminates the customary clevis pin and bushing which serve to connect the forward and back side rods and renders each of these rods interchangeable on a locomotive of this type where the driving wheel centers are an equal distance apart and the bearings of the same dimensions.

The *Railway Mechanical Engineer* is indebted to William Schlafge, mechanical manager of the Erie, for the following information concerning this special design of main and side rods:

"By referring to the accompanying drawing illustrating the details and manner of application of these rods, the difference between them and the usual type of connecting rods applied to ten-wheel locomotives will be readily observed. These rods were applied to locomotive 916 in April, 1917. Since that date only one complete set of new bushings has been applied. This is an exceptional performance. Moreover, we have not had a case of a hot pin on this locomotive since these rods were applied."

The simplicity of the design together with the interchangeability of the forward and back rods is also a feature of importance on a ten-wheel locomotive and there appears to be no reason why the same design could not be applied in principle to other types of locomotives having a greater number of driving wheels. Under certain conditions, the simplicity of design taken into consideration with the excellent results being obtained in use on the Erie would seem to recommend the design to more general consideration.

Kunze-Knorr Air Brake.—The final trials of the Kunze-Knorr air brake, preceding their adoption on the railways of Sweden, were made on the Ange-Braecke Line, which has an almost continuous 1 per cent grade, 20 kilometers long. The special freight train used in the test weighed 1,300 tons, and had a length of nearly 700 meters, being made up of 57 cars with 132 axles. Traveling at 45 kilometers per hour, with 8 brake vans, the train was stopped within 70 sec. in 605 meters. At a speed of 20 kilometers per hour, the corresponding figures were 38 sec. and 145 meters. The brakes are reported to have given full satisfaction for regulating the speed of the train.



Arrangement of Main and Side Rods Which Eliminates Knuckle Pins and Split Brasses

Railroad Labor Board. Standing, left to right: A. Phillips, L. G. Brooks, H. Baker, G. W. Hanger. Seated, left to right: H. T. Hunt, J. J. Forrester, R. M. Barton, chairman; W. L. Park, A. O. Wharton.

Railway Executives Testify Before Labor Board

Labor Unions Present a "Bill of Rights"; Roads Request Conferences to Discuss Wage Reductions

THE principal development in the hearings before the Labor Board during the past month was the summoning and cross-examination of several railway executives. B. M. Jewell, president of the Railway Employees Department of the American Federation of Labor, on March 5 asked the Labor Board to subpœna the members of the labor committee of the Association of Railway Executives, which was abolished, to appear as witnesses when he resumed his reply to the presentation made on behalf of the carriers in the national agreements controversy. The request was filed by Mr. Jewell as an answer to the action of the Association in abolishing the committee.

Several days previous Mr. Jewell filed a letter with the Board charging that the railway executives are in a state of dissension over the question of abrogating national working agreements. He urged that before proceeding further with the cases now pending the Board should rule on the request of the unions for a national conference with the railway managements over the agreements.

The letter charged that a year ago a majority of the railroad executives were in full accord with the union leaders on the question of establishing bipartisan boards of adjustment and declared that Gen. W. W. Atterbury as a "minority of one had ridden roughshod" over the other executives.

"He prepared a minority report," the letter states, "and presumably because of the support which he was able to secure from the financiers who dominate the transportation industry, was able to thwart the will of the other executives, prevent the establishment of the national boards of adjustment, and refuse any conferences on national agreements."

After a delay of two weeks, granted by the Board to Mr. Jewell to prepare his rebuttal statement to the presentation which had already been made on behalf of the carriers, Mr. Walsh and Mr. Jewell appeared before the board on March 14, stating in substance that "it will be impossible for us to proceed with the presentation of our case until the witnesses we have called for have been subpœnaed and have presented themselves for examination."

During the course of Mr. Walsh's opening remarks it developed that in reply to the employees' request for subpœnas, the Board, before taking action, had requested them to state what they expected to prove from the testimony of these witnesses. In reply to this Mr. Walsh stated that the employees expected to establish:

(1) What led to the carriers' decision to have National Agreements abrogated; (2) why the carriers have refused to meet representatives of the employees on this subject; (3) whether the executives are fundamentally interested in doing away with the waste and extravagance chargeable to the National Agreements; and (4), whether these executives really believe that National Agreements are unworkable, unjust and unreasonable.

In addressing the Board on March 14, Mr. Walsh said in part:

"My clients are in no sense responsible for the delays in these proceedings, nor will they remain silent under any such imputation. We have been ready from the outset to go forward in an orderly way to a speedy determination of the issues involved in this controversy, and we submit that the whole matter could have been disposed of weeks if not months ago, if we had been granted the conferences which we asked of the railroad executives, or if this board had taken steps to bring about such conferences.

"The delay has been both disturbing and costly to the general public. It has contributed largely to the uneasiness and uncertainty in all business and in all industry which have prevented that return to normal activity and productivity in which we are all so vitally concerned. It has recruited thousands upon thousands to the army of the unemployed. I, for one, am apprehensive of the economic and political consequences that may ensue when we have a horde of hungry men, women and children in this country."

On the insistent demand of Mr. Walsh and Mr. Jewell, Robert S. Binkerd, assistant to the chairman of the Association of Railway Executives; General W. W. Atterbury, vice-president of the Pennsylvania and chairman of the association's disbanded labor committee; Carl R. Gray, president of the Union Pacific, and a member of the labor committee before its abolishment, and Thomas DeWitt Cuyler, chairman of the association, were summoned by the Railroad Labor Board to appear before it on March 18.

In addition, members of either the old labor committee or the Conference Committee of Managers of the Association, were notified to hold themselves in readiness for a similar call. Mr. Binkerd was requested to bring with him the minutes, letters, recommendations and other records having to do with the proceedings of the association and its labor committee with reference to the dispute now before the Board.

These developments were brought about by the adoption of resolutions by the Board on March 14 after Mr. Walsh and Mr. Jewell had maneuvred for additional delay and again declined to meet the issue, namely, the justness and reasonableness of the National Agreements now in effect.

B. M. Jewell Presents a "Bill of Rights"

When this part of the hearings opened on March 18, Mr. Jewell read a "bill of rights," outlining the basic principles upon which he said the National Agreements are founded and for which the employees' representatives are fighting. This statement outlined in general the plan of attack later followed by Mr. Walsh in his examination of the various witnesses.

After stating that representatives of the employees have repeatedly attempted to have this controversy remanded to joint conferences and that "an aggressive and misguided minority of railroad executives has seized upon the question of National Agreements as the means of misrepresentation of the railway employees before the public and as the occasion for an attack on labor organizations," Mr. Jewell said:

"The fundamentals which are the basis of the National Agreement are as follows:

Eight hours as the recognized measure of the standard work day with an adequate hourly wage.

Payment for time worked in excess of the regular eight hours at proper over-time rates for the various characters of service required.

The beginning and ending of working shifts to be so arranged as to permit of reasonable living arrangements by employees and their families.

Reasonable rules for the protection of health and safety of employees.

Clear and concise definition of the work of each craft to be performed by mechanics and helpers.

The formulation of apprenticeship rules so as to develop sufficient, competent and efficient mechanics.

Applicants for employment as mechanics to be required to show that they have served an apprenticeship of four years or performed mechanics' work for a similar period and they not to be denied employment, when their services are needed, for any reason other than their inability to perform the work for which they are making application for employment.

The right of majority in each craft to determine what organization shall represent them. This organization to have the right to make an agreement which shall apply to all workers in each craft.

The right of the majority of each craft on each railroad to select a committee or representatives who shall handle all grievances which may arise affecting all employees of the craft in accordance with the provisions of the agreement.

Craft, point seniority, limiting seniority to the local shops or points and not permitting interchange of seniority with other shops, crafts, or departments of railroads.

The right to organize and the protection of employees against discrimination because of membership in labor organizations or for any other reason.

"These fundamentals constitute the irreducible minimum in labor's bill of rights," he continued. "If machinery is to be successfully established for the peaceable settlement of the disputes between management and employees on the railroads these fundamental principles are an absolutely necessary preliminary."

As a result of the carriers' recognition of thése principles, Mr. Jewell said that "well rounded and smooth running machinery would now be in operation and peace on railroads and good-will between management and employees would prevail where now exist growing distrust, dissension, dissatisfaction, and increasing rumblings of a fast approaching, costly and vicious conflict, such as existed in the railroad industry prior to December 31, 1917.

"If it is proper, and we admit it is," he continued, "for railroad management of all railroads to have a national union of management, then, by the same line of reasoning, it must be admitted that the employees are entitled to the same. Railroad management is willingly accepting all the benefits of the Transportation Act, and just as willingly and determinedly is it endeavoring to escape its burdens. The law itself is not being given the fair test which it should be given.

"The facts are, there is at present and for years past there has been no individual and independent railroad management with which the employees could bargain collectively. Railroad managements' labor policy is practically dictated by and through a small committee. Railroad managements' policy thus dictated is then sought to be imposed upon a local railroad craft organization of employees by and through the national union of railroad management. Railroad labor's organizations and policy are formulated in order that it may hope to successfully cope with the compactly and nationally organized union of railroad managements."

Cross Examination of Railroad Executives

Following the presentation of this statement Mr. Walsh called Mr. Binkerd, Mr. Cuyler, Mr. Gray and General Atterbury to the stand.

By the testimony of these witnesses Mr. Walsh attempted to prove:

1—That national boards of adjustment and National Agreements are inseparable.

2—That railway executives are divided on the question of national boards of adjustment and therefore on National Agreements.

3—That Mr. Cuyler and General Atterbury, alleged representatives of capital, have exerted a powerful influence in opposition to National Agreements as part of a general attack upon labor organizations.

4—That the carriers are organized nationally to treat labor and other problems and they therefore should treat with the employees nationally.

5—That the basic principles of the National Agreements are just and reasonable even when applied nationally.

6—That the railroads are unfairly moulding public opinion to influence the Labor Board.

7—That the labor policy of the railroads is dictated by a handful of executives.

8—That the Association of Railway Executives and its officers wield more than an advisory power.

From Mr. Binkerd, Mr. Walsh elicited information regarding the history, purposes, organization and powers of the Association of Railway Executives and detailed information regarding the files of that organization which he presented in accord with the order of the Board. From Mr. Cuyler, Mr. Walsh obtained information regarding his position and influence in the Association and the extent to which publicity work has been carried and by whom. Mr. Gray proved a distinct disappointment to the labor leaders, for he outlined in unmistakable terms the opposition of the executives toward continuation of National Agreements, and met every attack on their position with opinion and evidence gained through many years of railroad experience in every part of the country. Mr. Walsh retired from the examination after a short time, leaving the interrogation of Mr. Gray to counsel for the carriers.

General Atterbury completed the wreck of the hypothetical case as visioned by Mr. Walsh. He was not only not content to take the defensive, but at times took a hand in the questioning and backed up his contentions with proof.

It had been confidently expected by the labor leaders that, through the testimony of Mr. Gray, it would be possible to establish the existence of a difference of opinion among railway executives as to the justness and reasonableness of National Agreements, and thus materially weaken the carriers' case. However, the dispatch with which Mr. Gray killed this plan led Mr. Walsh, after a short time, to retire from the examination. Counsel for the railroads, however, asked Mr. Gray to present testimony as to the reasonableness or unreasonableness of National Agreements. To this Mr. Gray stated that the varied conditions existing in different parts of the country makes it practically impossible to devise rules which can be applied justly and reasonably over the whole country.

The "bill of rights," previously presented to the board by Mr. Jewell, was then brought to Mr. Gray's attention, and the manner in which these rules worked out in actual practice when applied universally, was quickly pointed out.

Cross Examination of General Atterbury

On March 21 General Atterbury took the witness stand, and, in response to questioning, outlined his connection with the Pennsylvania, the Association, its Labor Committee and other railroad organizations. This led Mr. Walsh to submit a long list of organizations of executives and subordinate officials, which, he maintained, treated railroad problems nationally, and inferred that questions in which the employees were interested should be treated on the same scale.

In answer to a question regarding the importance of the abrogation of National Agreements, General Atterbury said: "The abrogation of National Agreements is the most important thing before the country today."

During the progress of the examination, Mr. Walsh attempted to point out a difference in the positions taken by General Atterbury and Mr. Whiter's committee.

In reply to Mr. Walsh's request that he add something to Mr. Whiter's presentation, General Atterbury read a statement which said in part:

"No more serious question (National Agreements) confronts the American people today. We have come to a parting of the ways. One road leads to government ownership, nationalization, Plumb Plan-ism, and Syndicalism,—the other road, to industrial peace, and the continuation of that individual initiative, energy and responsibility which is peculiarly American. The issue is in your hands. The signboard on one road is: National Agreements. The signboard on the other is: Negotiate directly with your own employees.

"The following quotations from the Official Circular No. 107 of the Railway Employees Department of the American Federation of Labor, which circular as an interesting coincidence. is headed 'Yours for Government Ownership of Railroads'—are illuminating.

> We are the first class of railway employees to force the understanding that the Railway Administration would negotiate and sign a National Agreement.
>
> * * * it was up to him, the Director General, to settle with us and further * * * the entire proposition would be submitted to our membership at once for a strike vote.

"The other road I have indicated leads to industrial peace. I can quote no better testimony advocating following the signboard—'Negotiate with your own employees' than the following, taken from the Report of Industrial Conference called by the President, of which William B. Wilson, Secretary of Labor, was chairman, and Herbert Hoover, vice-chairman.

> The right relationship between employer and employee can be best promoted by the deliberate organization of that relationship. That organization should begin with the plant itself. * * *
>
> Industrial problems vary not only with each industry, but in each establishment. Therefore, the strategic place to begin battle with misunderstanding is within the industrial plant itself. Primarily the settlement must come from the bottom, not from the top.

"My views as to what the employees should not do, are as follows: (1) undermine discipline; (2) limit production; (3) demand pay for which there is no equivalent production; and (4) force the 'closed union shop.'

"I have no fight with organized labor as such. I have every desire to see its existence healthy and normal. Within reasonable limits, it is a healthy spur to bring about fair conditions as between employer and employee.

"My views as to what the employee has the right to expect and the employer should provide, are as follows: (1) as steady employment as possible; (2) a good wage; (3) time for recreation; (4) opportunity to elevate himself in his employment; (5) a voice in determining the rules and regulations under which he should work; and (6) the right to be, or not to be, a union man. But to apply these principles, the 'dog collar' of National Agreements must be removed.

"An agreement to be properly binding must be equitable, and entered into freely by both parties; and in order that it may be intelligible and properly carried out, it is necessary that there be a common understanding. But a common understanding can only come from free discussion and negotiation.

"The so-called National Agreements were put in force on the Pennsylvania by order of the Director General. No discussion whatever was held between the employees who would work under these agreements, and the officers who necessarily would have to administer them. Nor have the employees who work under these agreements been permitted by their leaders to discuss them with their own railroad officers, or modify them as a result of such discussion."

After calling attention to the hurried effort on the part of the leaders of the shop crafts to make the question of National Agreements an issue before the Board, General Atterbury continued:

"Confusion, misunderstanding and bitterness between the officers and the employees were bound to, and did follow, and are bound to continue until the so-called National Agreements are wiped out, and the officers and employees now working under them on the Pennsylvania sit down together and work out their own set of working rules to meet their own conditions. You may fairly ask what justification I may have for this statement I have just made. Your Board some time ago very wisely decided that it had no jurisdiction over the question of national boards of adjustment. That decision took that 'dog collar' off. What followed on the Pennsylvania with our men in train and engine service is typical and convinces me of the possibilities in this direction with all classes of employees. There are no cases before the Labor Board from our men in train and engine service involving grievances as a result of the train and engine service rules and working conditions on the Pennsylvania. Our men and our officers are settling them between themselves. Understand that there were in existence seven separate schedules, covering different parts of the system and you must recognize that we have varying conditions incident to serving a territory with agricultural, industrial, and climatic differences, that stretches from the straits of Mackinaw to the Chesapeake Bay, and from the Atlantic Ocean to the Mississippi river and the waters of Lake Michigan.

"Each railroad negotiating its schedules with its own employees is the road to industrial peace."

There followed an interesting controversy between General Atterbury and Mr. Walsh as to the formation of the various National Agreements. General Atterbury vigorously maintained that these agreements were obtained from the Director General by coercion and stated, in support of this contention, that Director General Hines "took strike threats too seriously; his experience in handling labor matters had been too limited."

The next move in the examination was openly announced by Mr. Walsh when he said: "I will now try to prove that some universal rules are necessary." Following this he introduced considerable evidence regarding the legislation designed to safeguard railroad workers, various uniform rules promulgated by the Interstate Commerce Commission, etc. He then took up the rules contained in the National Agreements, and immediately found that, instead of examining the witness and directing the trend of the testimony, he was in turn being examined, and that the trend of testimony was being directed by General Atterbury. The first rule of the Shop Crafts Agreement was presented for General Atterbury's approval. It brought forth the reply:

"The eight-hour day is a perfect farce. It is merely a means for getting more money. The rule typifies the whole business. Why doesn't the rule say 'eight hours' work shall constitute a day,' instead of 'eight hours shall constitute a day's work.' "

General Atterbury then continued to bring out defects in the universal application of rules, stating again and again in discussing the applicability of the eight-hour day to railroad service that "the length of the working day should be gaged by the character of the service rendered." The remainder of the morning session was devoted to efforts on the part of Mr. Walsh and Mr. Wharton of the board to get General Atterbury to commit himself against the basic eight-hour day, but these efforts were without avail. In discussing other rules of National Agreements, General Atterbury took and consistently maintained the position that "no rule is a good rule unless it is agreed to by the officers who apply it and men who work under it."

Inadvertently, perhaps, Mr. Walsh then mentioned the relative merits of piecework as compared with the hourly wage system. This led to vigorous defence of piecework by General Atterbury, who said: "The abolition of piecework has been made a bone of contention by men who would level all good Americans."

General Atterbury said: "I would negotiate agreements with our men right now if their leaders would let go." To this Mr. Walsh replied that he, General Atterbury, could legally negotiate agreements with his own men at the present time. The latter was evidently waiting for this opporunity, for he immediately produced two communications from the Railway Employees' Department of the American Federation of Labor to members of the shop crafts, telling them, in substance, not to negotiate any agreements except the complete National Agreement. Furthermore, General Atterbury took this opportunity to substantiate his term for the National Agreement—"dog collars." This expression, he said, originated in a cartoon contained in a bulletin issued by the Railway Employees' Department of the American Federation of Labor, portraying labor handing railroad management a small dog collar labeled "National Agreement." Railroad management is saying, "It won't fit." Labor is replying, "We'll make it fit." How the "dog collar" was made to fit was explained by General Atterbury by reading portions of the communication below the cartoon.

The result was both serious and amusing. Mr. Walsh, aided by Mr. Wharton, attempted to draw different conclusions from labor's statement, "We'll make it fit," but their attempts were not successful, and the course of the examination was quietly but quickly changed; however, not before General Atterbury had vigorously stated, "The leaders of the American Federation of Labor are throttling the employees and the National Agreements are throttling both the employees and the management. I don't want to take anything from the employee. I want only a fair day's work for a fair day's pay." In answer to a question by Mr. H. T. Hunt, a public member of the board, Mr. Atterbury said: "You cut the 'dog collar' off and see how quickly the Pennsylvania will negotiate agreements with its men."

On continuing this line of examination, General Atterbury exclaimed that the "whole object of National Agreements is to employ more men." Objections to this statement elicited the reply: "I am a better friend of the men than their own representatives at this table. I maintain, in fact, that the men are not being represented."

The remainder of the day's testimony was of a similar character, Mr. Walsh endeavoring to obtain General Atterbury's approval of the principles of various rules of the Shop Crafts Agreement, and General Atterbury consistently maintaining his position as has already been outlined.

The morning session on March 22 found General Atterbury still on the stand with the cross examination proceeding without results for the employees' case. The necessity for classification rules was first brought up by Mr. Walsh only to be denied in substance. Regarding this, General Atterbury testified: "I take it that this Board is to quiet not foment trouble. If it were to write standard rules instead of pouring oil on the waters it would be throwing rocks into it. The Board can't write standard rules."

Mr. Walsh stated that there have been but 175 disputes in a year under the National Agreements, and upon asking General Atterbury if that would not indicate harmony under these rules, the latter replied: "No. The boards at Washington have already given the men everything they have asked for. There is nothing more to request."

The apprentice rules in the Shop Crafts Agreement were next taken up, Mr. Walsh attempting to justify their existence by reference to so-called "abuses" which took place prior to their creation. This discussion ended when General Atterbury said: "I can find restricted production under every rule of the National Agreement, and this rule is no exception. You men are trying to get more money for the men; I am trying to get an honest day's work for that pay."

Regarding the representation of employees, General Atterbury maintained through a long series of questions that the principle of representation by men elected by the majority is not fair to the minority who have a right to be represented by men of their own choosing. Following this, General Atterbury outlined his definition of and views upon the "closed shop," stating in substance that he deprecates the closed non-union shop as well as the closed union shop. Furthermore, he read a circular issued by the Railway Employees' Department of the American Federation of Labor showing that that department has issued orders which establish closed shops.

The testimony during the afternoon session of the same day continued the same. Various of the rules were brought up by Mr. Walsh, and General Atterbury as strenuously objected to their application nationally.

Mr. Walsh attempted to capitalize the evidence that the Pennsylvania had maintained prior to General Atterbury's departure for France "an extensive espionage system among its employees" and had "little arsenals" at various plants. After lengthy discussion of the charges of coercion on the part of both the Pennsylvania and the employees, the subject finally dropped upon a promise by Mr. Hunt to read General Atterbury's complete report from which the charges were taken. Just prior to the closing of the morning session, Mr. Walsh produced a letter alleged to have been written by I. W. Geer, general manager of the Pennsylvania, southwestern region, to supervisory employees, in which he charged the supervisory employees to defame the labor organizations if necessary to obtain certain information. This letter was later declared to be a fake by General Atterbury and Mr. Whiter after they had communicated with Mr. Geer.

Mr. Walsh later turned to apparent discrepancies in statements as to the cost of the National Agreements. General Atterbury immediately produced a statement which Mr. Walsh tried to keep from the record. This statement, which was filed with the Board, showed by figures of the Interstate Commerce Commission that the estimated saving of $300,000,000 was far below the actual saving possible.

A long series of questions regarding Master Car Builders' rules, etc., and their necessity followed, but throughout the session General Atterbury maintained consistently the stand which he had already taken on this subject. This completed the examination of witnesses summoned so far, and the Board adjourned until March 24, when Mr. Jewell began presentation of a long statement in reply to General Atterbury's stand before the Board.

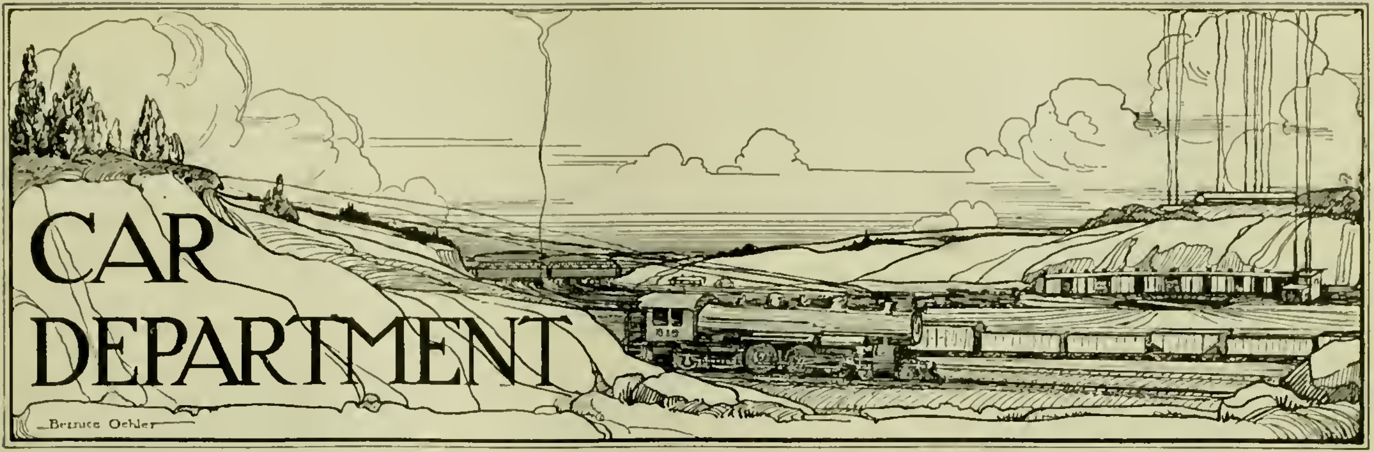
Developments so far have not indicated when or how the labor leaders will attempt to answer Mr. Whiter's presentation, but from their present tactics it is assumed that this will not be presented until the Board has decided that the case has been delayed long enough.

Developments in Other Hearings

On March 1 representatives of the Brotherhood of Railway and Steamship Clerks, Freight Handlers, Express and Station Employees appeared before the Board to justify the agreements made with the clerks and present their rebuttal statements. Statements were also made by representatives of the signalmen and the Brotherhood of Maintenance of Way Employees and Railway Shop Laborers.

Wage Reductions Proposed on Many Roads

During the past month many roads have held conferences with their employees to discuss decreases in the wage scale. In a great majority of cases the men are not disposed to accept any reductions without action by the Labor Board. While the earlier conferences were confined principally to unskilled laborers, later developments include proposals to reduce wages of all classes of officers and employees.

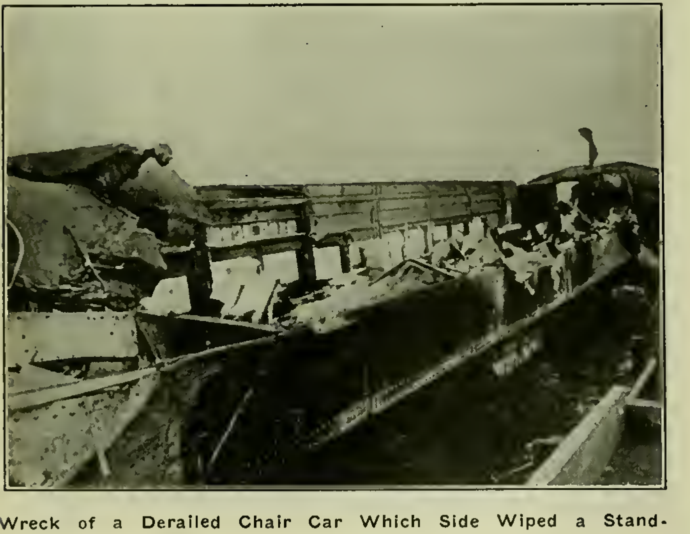


The Safety of Passengers in Steel Railway Cars*

A Discussion of the Action of Cars in Accidents and Methods Which Will Avoid Telescoping

BY FRANK M. BRINCKERHOFF

THE general adoption of steel in place of wood in the construction of passenger train cars some 15 years ago marked a distinct advance in the art of car building. Various problems arose during the change, and many have been successfully met. The two most important problems to be solved were and still are: safety of passengers and weight of complete car.



Wreck of a Derailed Chair Car Which Side Wiped a Standing Locomotive

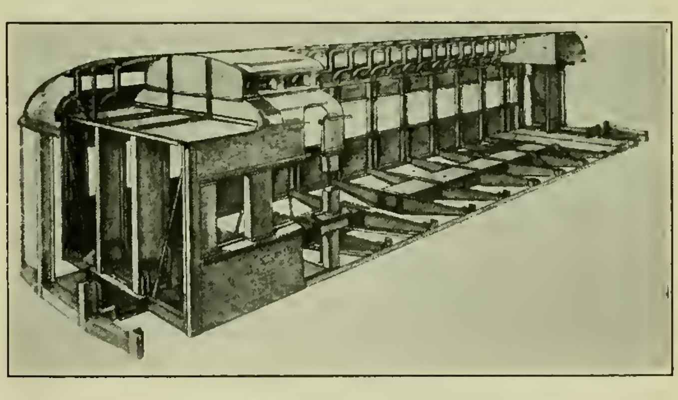
To successfully defend the passenger space against invasion in side wiping collisions and derailments, strong sideposts must extend from side sill to roof and all the side frame members must be co-ordinated to ward off the colliding body.

That some steel passenger cars are heavier than the wooden ones which they displace in service, seems to be indicated by the significant fact that the adoption of steel passenger train cars was frequently accompanied or closely followed by the purchase of heavier locomotives to handle the new passenger equipment.

It is not the intention at this time to discuss the economic consequences of the increased weight of steel passenger train cars, though that aspect is, of course, very important.

With regard to the problem of safety of passengers, I wish to present in a condensed form the results of an extended investigation of the behavior of passenger train cars when derailed or in collision, and to point out that, while the steel structure affords much greater safety to passengers than did wooden car bodies, modifications can be made in the superstructures of steel cars which will greatly increase their ability to resist destructive shock.

The data and some of the illustrations from which this paper is compiled can be found in the printed reports of accidents investigated by the Bureau of Safety, Interstate Commerce Commission, which are available to all; other illustrations are from photographs taken by various pictorial news bureaus and have appeared in the daily press, and a few are from our office files.



Framework of Passenger Car

Showing collision diaphragm and bulkhead with high-girder side walls.

In making our collection many hundred prints were examined and only those were selected which are of interest to car designers. It is greatly to be regretted that frequently the only available photographs of a wreck were taken as general views of the accident. Many valuable photographic studies of structural failures could have been made by an expert on the spot.

It was natural that the early designs of steel car structures should follow conventional lines and that the evolution from

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*From a paper presented before the New York Railroad Club, March 18, 1921.

the all-wood car to the all-steel car should be gradual. It is now possible, however, to examine the photographic records of typical accidents to passenger trains and profit by past experience when designing and building new equipment.

For the purpose of analysis the illustrations have been divided into two groups: derailments and collisions. The records of the Bureau of Safety show that by far the greater number of accidents are in the derailment class though the loss of life and injury to passengers and equipment is greatest in the collisions.

Derailments

Examining first the large derailment class it is found that a considerable portion of the momentum of the train is gradually expended in plowing up the roadbed and in tossing about the car bodies. Therefore, the violence of impact between the individual derailed cars is not comparable to the shock experienced in a rear end collision between a moving and a standing train wherein the momentum of the combined units of the moving mass, led by the locomotive, is concentrated in an impact upon the rear units of the standing train. This reduction in the degree of violence of impact is, however, somewhat offset by the fact that when cars are derailed the heavy underframe of one car is frequently projected against the relatively weak superstructure of an adjoining car with more or less disastrous results. Furthermore in derailments the cars are sometimes overturned or fall upon a neighboring car; in such cases the superstructure of the car is subjected to extremely severe stresses.

Examination of many illustrations of accidents of the derailment and side wiping class, led us to the conclusion that distribution of metal which would strengthen the superstructure of the car as compared to the strength of the underframe was highly desirable. During the last 10 years or more, 315 cars have been built according to a system evolved, with the purpose constantly in mind, to produce a car body structure of great strength, but still of a weight not in excess of wooden car bodies of similar size and equipment. I wish to introduce at this point a short description of this system which affords unusual protection to the passenger space when cars are derailed or side wiped.

A Car Body Structure of Greater Strength

The sideframe members of these cars are organized in the form of a girder extending from the side sill to the side plate at the roof line, a height of 7 ft. 6 in. or more. The underframe of this system includes centersills adequate to sustain the shocks of collision, draft, etc., but instead of being of the fish belly type, designed to be self-supporting between truck centers, as is the usual custom, the centersills of this system are uniform in section throughout their length and are supported approximately every six feet by heavy cross bearers between the high girder side frames. The centersills, being thus supported, have no measurable deflection and are, therefore, superior in capacity to resist end shock to those of much greater weight and depth which are self-supporting between bolsters. By this co-operation between side frames and centersills a great reduction in weight per car is accomplished and yet a much stronger body structure results.

The ends of the bodies of these cars are reinforced against the stresses of impact to an extent considered appropriate to the service in which the cars are employed, some of these cars being electrically operated in tunnel service, others in suburban steam and suburban electric service, others in through line steam service at high speeds and in heavy trains. The system of end reinforcement is, of course, carried to the greatest extent in the cars in the latter service where the greatest momentum is to be dealt with in case of accident.

This system of reinforcement of the ends of the car body co-ordinates the body end walls with the members of the high girder side frame and roof in the form of a rectangular tube with ends barred to prevent penetration by an impacting body. This is accomplished in the through line cars by the introduction of two new members:

1. An anti-telescoping tie plate extending across the car from side plate to side plate and lengthwise of the car for about six feet forming a flat ceiling for the lavatory, passageway and saloon and being securely riveted to the plate of the high girder side frame.

2. Special deep piers forming the posts for the door in the end of the car body. These piers are approximately 21 in. deep and as in some classes of accident they may be subjected to tension. The web plates of these piers pass through the upper tie plate and also through to the underframe and are, together with their flanges, securely riveted to each of these members. The corner posts and the adjacent side posts of the car body are also specially designed to withstand the shock of cornering collision.

First Stage of Telescoping of Steel Cars

The body of the chair car has overridden the buffer sill of the coach.

The car structure thus formed is illustrated in the perspective drawing shown, from examination of which it will be seen that the compression member of the high girder side frame effectively braces this reinforced body end at the roof line.

The extent to which the high girder side frame and body end reinforcement of passenger car bodies will protect the passenger space when in collision or derailment can be somewhat gaged by examination of the damage to steel baggage cars after being involved in accidents of these classes. Baggage cars, because of the typical arrangement of their side doors, windows, etc., have in effect high side frames, with the elements of plate girders, extending from side sills to roof line at the car body ends. The high girder side frame and body end reinforcement of passenger cars, above described, co-ordinates all the strength elements of the car structure even more effectively than does the form of plate girder side walls of the usual baggage car, and in addition the body of the passenger car will be protected to a certain degree by the wreckage of its vestibule which, when in collision, will be forced back against the reinforced body end. Comparatively little damage results to baggage cars with high side walls when colliding with coaches of the usual low frame construction, thus demonstrating the advantage of the high structure when subjected to end shock.

End View of Coach Shown in Previous Illustration

The chair car has commenced to exert a bursting stress upon the body of the coach.

Rear Collisions

Considering next the illustrations of typical rear collisions, it is interesting to note that, where cars with steel underframes are involved, the penetration by the locomotive into the rear car seldom exceeds the depth of the vestibule and that the greatest damage occurs where one car overrides another. The pilot of the locomotive usually underruns the rear car until the buffer sills of the car come in contact with the heavy frame of the locomotive, where further progress is arrested and the penetration of the vestibule structure by the locomotive boiler or smoke box ceases.

When one car overrides another the penetration is in some instances complete, the entire length of the invaded car being practically destroyed. Careful analysis of typical photographic records of railway wrecks will lead to the following conclusions:

1. The underframe of the modern steel passenger car is adequate to withstand the shock of the most violent collision.
2. The underframe of the invading car overrides the underframe of the invaded car and wedges its side walls apart, the point of impact being a foot or more above the floor according to the upward angle assumed by the overriding underframe.
3. The superstructures of steel cars fail to protect the passenger space, when overridden in collision by a car having a steel underframe, because of the relative weakness of the invaded superstructure as compared with the heavy underframe of the invading body.
4. The joints connecting the side walls, hood and roof are subjected to tension because the invading body having penetrated between the side walls, exerts a bursting stress on the invaded structure. The members composing the roof are always light in section and the joints connecting them to the sides inadequate to resist the heavy tension stress of collision.
5. The structure of the invading car is subjected to compression, and as the joints connecting its members are better able to resist compression, than the invaded car structure is to resist tension, the invading car body is seldom seriously damaged.

Accurate computation of the force expended in a collision between trains is practically impossible. Two reactions, however, occur in all rear end collisions, which can be used to roughly gage the violence of the shock, namely:

1. Depth of penetration by the invading car, and
2. The distance the standing train is driven ahead by the force of the collision.

These reactions are complements of each other and roughly indicate the energy expended.

With these reactions in mind it seems highly desirable that the invading car be restrained from penetration by some device which will cushion the impact shock and impart motion to the standing train, thus diverting the force from the work of destruction to the work of moving the mass.

It is obvious that in a train collision the points of impact will be more or less damaged. It is impossible to build a car structure that will successfully resist all damage by an overriding car. The problem is to provide means to arrest the progress of an invading car before it penetrates deep into the invaded structure, meantime transmitting the force of the collision to the standing train to set it in motion.

The Second Stage of Telescoping

When telescoping has reached this stage the structure can offer but little resistance to further penetration by the invading body.

The essence of this problem is the element of *time.* The structure best adapted to solve the problem must contain members which will act to resist penetration at the vestibule end and interpose a rapidly increasing resistance to the progress of the invading car.

The essential characteristics of a member best suited to accomplish the above ends are: *Flexibility* to avoid shearing; *elasticity* to avoid abrupt stressing; *high ultimate strength* in tension to resist bursting stress exerted by an invading car.

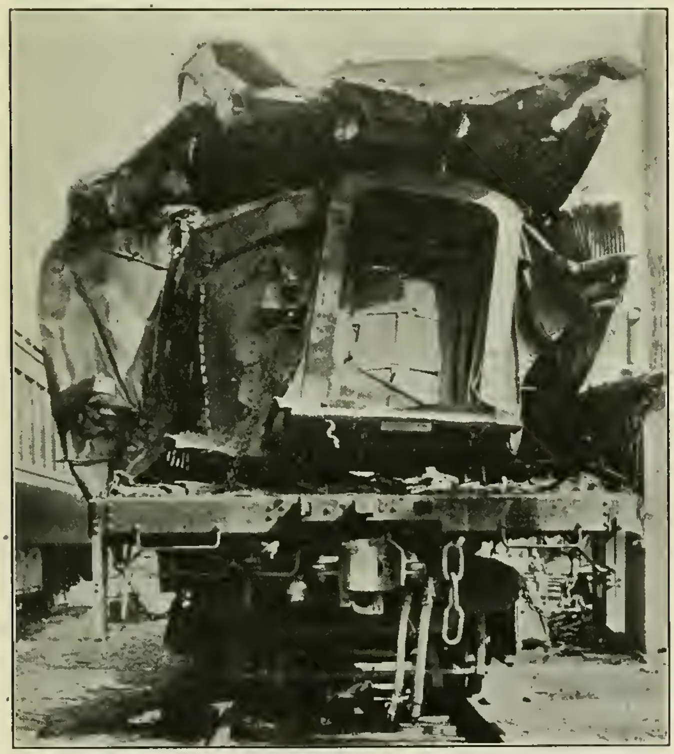
Use of Wire Cable Proposed as Remedy

Manifestly the material best adapted to meet the above requirements is *wire cable.* The manner of introducing the wire cable in a car structure may vary considerably. One form may be described as follows:

A wire cable anchored to the underframe of the car, passing through the vestibule buffer sill, up through the vestibule corner post, across the hood, down the opposite corner post, through the buffer sill to the anchorage point at the underframe.

The loop is thus distended in such a manner that the vestibule end of an invading car will penetrate within the loop. The initial shock of collision will be met as now by the vestibule end posts. When the resistance of these end posts is overcome and as the invading body progresses, the cable loop, together with the members of the invaded vestibule will be drawn in and down against the vestibule of the invading body crushing both within the confines of the loop.

The more resistant the structures thus crushed, the greater will be the energy absorbed and the greater will be the pull exerted by the cable, through its anchorage in the underframe, to impart motion to the mass.



End View of the Car Shown in the Last Illustration

The design further provides for a second group of cables, imbedded in the body corner posts and body end frame, to act as a second line of defence against the invading car. Should the force of the collision be not completely dissipated through the resistance of the vestibule end posts and the cable in the vestibule end, the invading car body will next encounter the high resistance of the body end wall, and the second group of cables will come into action upon being encountered by the invader. The second group of cables being also anchored to the underframe and distended in loop form will also draw the structure of the invaded car down and in upon the invader and similarly impart motion to the mass. This second group of cables will also act to draw downward and inward the roof and sides of the invader.

The size and number of the cables and the number of groups or lines of defence can be increased until all reasonable doubt of their collective ability to arrest an invading car disappears.

In the absence of the wire cables, a corresponding collision would result in wedging apart the invaded structure with comparatively little dissipation of energy and imparting but little motion to the standing cars, because the energy expended in wedging aside the members of the structure is exerted at almost right angles to the direction of the invading body and consequently, results in but little forward thrust.

The arrangement of the cables is purposely such that it is impossible to bring an abrupt stress on them. They are distended in an approximately rectangular loop by members which, when subjected to collision shock, are bent and distorted by the cable which is of superior strength to any member with which it is associated except only the centersill to which it is anchored. For example the combined tensile strength of the cable loops shown in the illustration is 2,000,000 lb., and therefore equivalent to the ultimate strength of centersills having a cross section of approximately 50 sq. in. Consequently when a car body protected by cables is invaded, the vestibule of the invader will be crushed down and the zone of destruction in the invaded car will be limited to the area enclosed by the cable loops engaged.

The Final Stage of Telescoping

The complete separation of the side walls of the invaded car indicates the desirability of incorporating strong tension members in the superstructure.

Length of Path of Resistance

Thrust will be imparted to the centersills of the car in which the cables are incorporated, from the moment of impact upon the vestibule end and in a gradually increasing degree until all the cable loops are drawn in and down to a position of rest against the crumpled structure of the invading car. This prolonged and steep path of resistance is of the utmost importance.

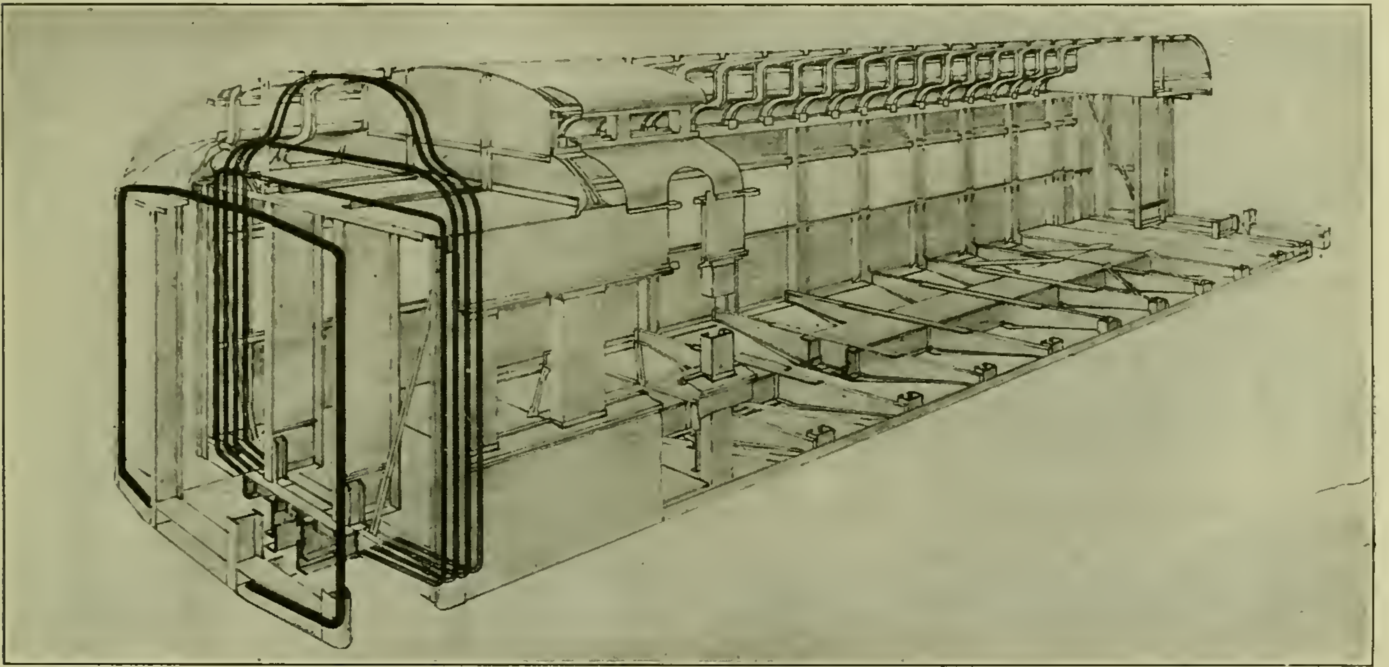
In the illustration the cable loops are shown in combination with a high girder side frame and body end reinforcement as first described. This we consider the strongest form of car body construction in use today. When completely equipped with cable loops, this design provides the following path of resistance to penetration by an invading body:

1. A rigid vestibule end wall having as high initial resistance as practicable.
2. Cable loop, enclosing the vestibule end wall and acting to retain the structural members in the path of the invading body, upon the failure of the initial resistance of the vestibule end wall.

3. A rigid body end wall including the strong piers at the doorway and the deep body end reinforcing plate, collectively over five times the section of the vestibule end.

4. The second group of cables which will act to prevent disruption of the body end wall structure and any further penetration.

The resistance effected by the cable loops is accumulative and the ultimate resistance will not be reached until the wreckage of both vestibules is compressed in a tangled mass within the confines of the loops engaged. The crumpling of the structural members within the cable loops will act to cushion the shock. The resistance will increase rapidly in a series of steps beginning with the resistance afforded by the rigid vestibule end posts and reaching a peak equal to the accumulated resistance of the four stages in the path of resistance above described. The body end structure being of much greater strength than the vestibule end structure will insure that the vestibule structure must be practically destroyed before the initial resistance of the body end structure is overcome, and the second group of cables called upon to resist further penetration. I believe that only in cases of the utmost violence will the body end of the invaded car be crushed in and the ultimate resistance of the main cables be developed. For example, in some of the complete telescoping cases illustrated the initial resistance offered by the vestibule and the body end construction of the invaded car was inadequate to prevent penetration. The secondary resistance offered by the roof structure and the interior fittings was negligible as compared to that which would have been afforded by wire cables of 2,000,000 lb. (1,000 tons) capacity which would have checked the invader at or near the point of entrance. It is my opinion, that in cases of extreme violence, and before the vestibule structures have been completely compressed, the thrust transmitted to the underframe of the invaded car, through the medium of the cables, will be sufficient to impart motion to the standing train and thus dissipate a large proportion of the energy of the collision.



Reinforced Body End with Cable Loops

We are all familiar with shock absorbers in daily use, such as rubber heels, pneumatic tires, truck springs, buffing devices, draft gear, etc. All these devices introduce a time element, or path of resistance, commencing at the instant of impact and increasing in resistance until the shock is absorbed or the device becomes solid. The introduction of the strong cable loops in the car structure, produces a collision shock absorber which may be compared to a buffing device in which the maximum length of path of resistance, or travel, is only limited to the confines of the loops engaged instead of limited to a few inches travel. Time will not permit of entering into details of the method of incorporating the cable loops in the car structure. It is the intention, however, that all the structural members be retained by the cable loops within the path of the invading body to make resistance to penetration during the time the loops are being drawn down as great as possible.

In the foregoing description of a car adapted to resist the shocks experienced in sidewiping, derailments and collisions we have naturally illustrated and described the design of car which we have ourselves evolved while guided by a close study of the collection of photographic records of accidents which we have been accumulating for a number of years. Manifestly the cable system of reinforcement can be incorporated in any adequate design of vestibule end and body end construction. I, however, believe that a car embodying the strong superstructure, with strong vestibule and body end construction as outlined above is particularly well protected against damage in accidents of the derailment and sidewiping class and further that such a car fitted with the limiting loop of wire cables as described will be as safe against invasion by a telescoping body as now seems possible.

Adjustment of Brake Power on Tank Cars

Some confusion has arisen as to the provisions of circular S. III-11, issued in May, 1919, by the American Railroad Association, Section III-Mechanical, specifying the adjustment of brake power on tank cars.. The mechanical division of the American Railway Association has issued Circular S III-193 revising the original instructions.

The original circular states that the minimum average power brake equipment should be 60 per cent of the light weight of the car, based on a cylinder pressure of 50 lb. per sq. in. In order to eliminate the confusion which has been caused by the use of the word "minimum" in connection with the 60 per cent braking power, causing some to believe there is no limit to the maximum percentage of braking power that may be employed, the paragraph in question has been changed to read as follows:

> The recommended practice of the association provides that the air brake power for freight equipment should be 60 per cent of the light weight of the car, based on the cylinder pressure of 50 lb. per sq. in.

The sketches shown in Circular S III-11 specifying the methods of making end brake connections at the cylinder lever, did not clearly indicate that the brake chain should be connected at the top of the drum on the lower end of the brake staff. In the revised circular sketches of the brake chain connections have been shown in which the proper attachment of the chain to the top of the drum or barrel is clearly indicated, and a paragraph clearly specifying this location has been added to the instructions.

Some car owners have endeavored to provide the hand brake power specified by lengthening the piston ends of the live cylinder lever to provide a hand brake connection (instead of by the method specified in Circular S III-11 and the specifications for tank cars, regardless of the fact that by so doing the equalization of the hand brake power on the two trucks is seriously disturbed. In order to cover this point clearly the following paragraph has been added:

> Cars are not in accordance with the requirements if (a) the hand brake connection is made to an extension at piston end of live cylinder instead of to the push rod as shown in Figs. 1, 2 and 3, of Circular S III-11; (b) unless the body and truck levers are properly proportioned for the percentage of brake power specified for the air brake, or (c) on which the percentage of brake power for the hand and air brake is not equal on both trucks.

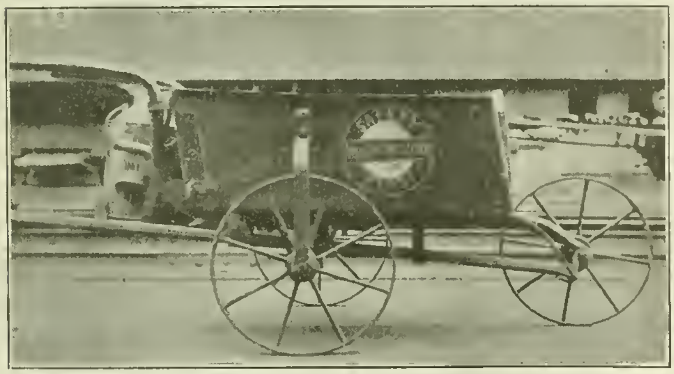
The two sentences in the first paragraph under "Adjustment of Hand Brake Power" in Circular S III-11 have been confused to the extent of considering the second sentence without regard to the preceding one, cases having been reported in which the brake power for the air brake system was less than 27 per cent of the empty car weight. To make these instructions clear this paragraph has been changed to read:

> With the body and truck lever properly proportioned to 60 per cent braking power on each truck, as specified in the foregoing, and based on the formulae and diagrams shown herein, the hand brake wheel or the hand brake ratchet lever, brake staff and chain, and the hand brake leverage between brake staff and cylinder shall be so proportioned that a force of 125 lb. at the rim of the brake wheel or 3 in. from the outer end of hand brake ratchet lever will develop an equivalent load *W* at the brake cylinder piston of not less than 2,500 lb. and 3,900 lb. respectively, for cars having 8-in. and 10-in. cylinders.

Emergency Truck for Car Repairs

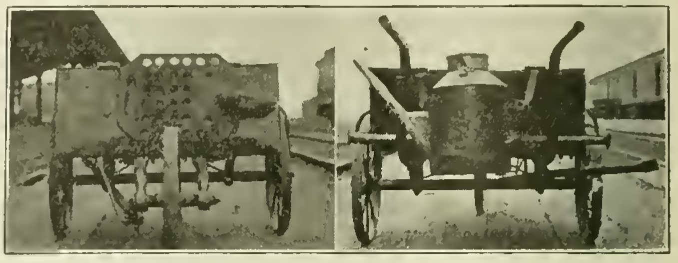
BY E. A. AUSTIN

A truck for carrying the materials and tools necessary for making light repairs is a handy device for use at passenger stations. Such devices are not widely used although they have proved a great help in expediting work. The type shown in the illustration herewith is used at Milwaukee on the Chicago & North Western. One of the advantages of the design is that it is built low enough to pass underneath cars, being only 27 in. high. This saves the time ordinarily wasted in running around the train in case the work must be done on the opposite side from that on which the truck happens to be.



A Side View of the Repair Truck

As shown in the rear view, a large oil can is carried between the handles of the truck. In the front of the body, there is a jack plate with a goose neck that catches the rim of the wheel and holds it on the rail when jacking up the box to change brasses. The long bar resting on brackets at the side of the truck answers for two purposes. One end is square for driving in wedges and the other has a point shaped like a parrot bill for throwing over the lateral of the axle or for removing the wedge in case it binds when the car is jacked up.



A Jacking Plate and An Oil Can Are Carried on the Front and Back of the Truck

The interior of the truck has five compartments. Two are used for buckets of prepared packing, one for the journal jack, one for brasses and one for blocking. It is customary to carry one block 3 in. by 10 in. by 24 in., one 1½ in. by 10 in. by 24 in., and an iron plate ½ in. by 8 in. by 12 in., which is convenient to use where there is not sufficient space to get a thicker block under the jack.

Virginian 120-Ton Cars

Among the illustrations accompanying the description of the 120-ton coal cars for the Virginian, published in the March issue, there is a plan and side elevation of the body, which appeared on page 164. Several incorrect dimensions are shown on this drawing. The distance from the center line of the body bolster to the striking plate, should be 7 ft. 3½ in., instead of 6 ft. 11 in. The distance between truck centers should be 36 ft. 1¾ in. and not 36 ft. 10¾ in. Both these dimensions are correctly given in the details of the underframe and draft gear on pages 165, 166 and 167. The wheel base of the truck is shown on the drawing of the car body as 8 ft. 8 in., whereas the wheel base of the Buckeye truck used was 8 ft. 6 in., of the Lewis truck 9 ft., and of the Lamont truck, 8 ft. 3 in.

Strikes on Southern Roads.—A strike was ordered by the labor organization on the Missouri & North Arkansas on February 27, when enginemen, trainmen, telegraphers and station agents left their work. An attempt was made to resume service, but after a time C. A. Phelan, receiver and general manager, issued a statement to the effect that service would be suspended because depredations which had been committed would endanger the lives of passengers and employees.

The Atlanta, Birmingham & Atlantic was placed in the hands of a receiver by Judge Sibley of the United States District Court, Atlanta, Ga., on February 25. Later Judge Sibley signed an order putting into effect the schedule of reductions which Mr. Bugg, president, and later receiver of the road, had urged before the Labor Board. On March 5 a strike was authorized and about 1,500 men walked out. The places of the striking employees were filled as rapidly as possible, and local passenger and freight service was resumed after a short interruption.

Draft Gear Tests of the Railroad Administration

Second of the Series of Articles Describing Investigations Conducted by the Inspection and Test Section

After measuring the test gears and reassembling them with their parts in their original positions, the 9,000 lb. drop tests were made. Except for a few gears that were added at a later date, the original series of drop tests was made at the Mt. Clare shops of the Baltimore & Ohio Railroad. After the car-impact tests at Rochester, the same gears were submitted to a second series of drop tests under the Pennsylvania Railroad machine at Altoona for check purposes.

The drop tests were in all instances made with the gears supported upon a solid anvil. Before beginning the drop tests of either of the above series each gear was given a certain amount of preliminary work to insure the proper seating of the parts. The uniform practice was followed of first determining the drop test value of each gear, by dropping the weight from 1 in. free fall and then increasing the fall by 1 in. increments, until the closing point was reached. The gear was then given 10 blows from 1 in. below the solid height, which usually resulted in building up the capacity of the gear slightly. After this preliminary work the regular drop tests were made, the tup being again dropped through heights increasing by 1 in. increments until the closing point was reached. In the case of gears such as the Harvey springs the solid point was previously determined from a preliminary static test and this point worked to in the drop test.

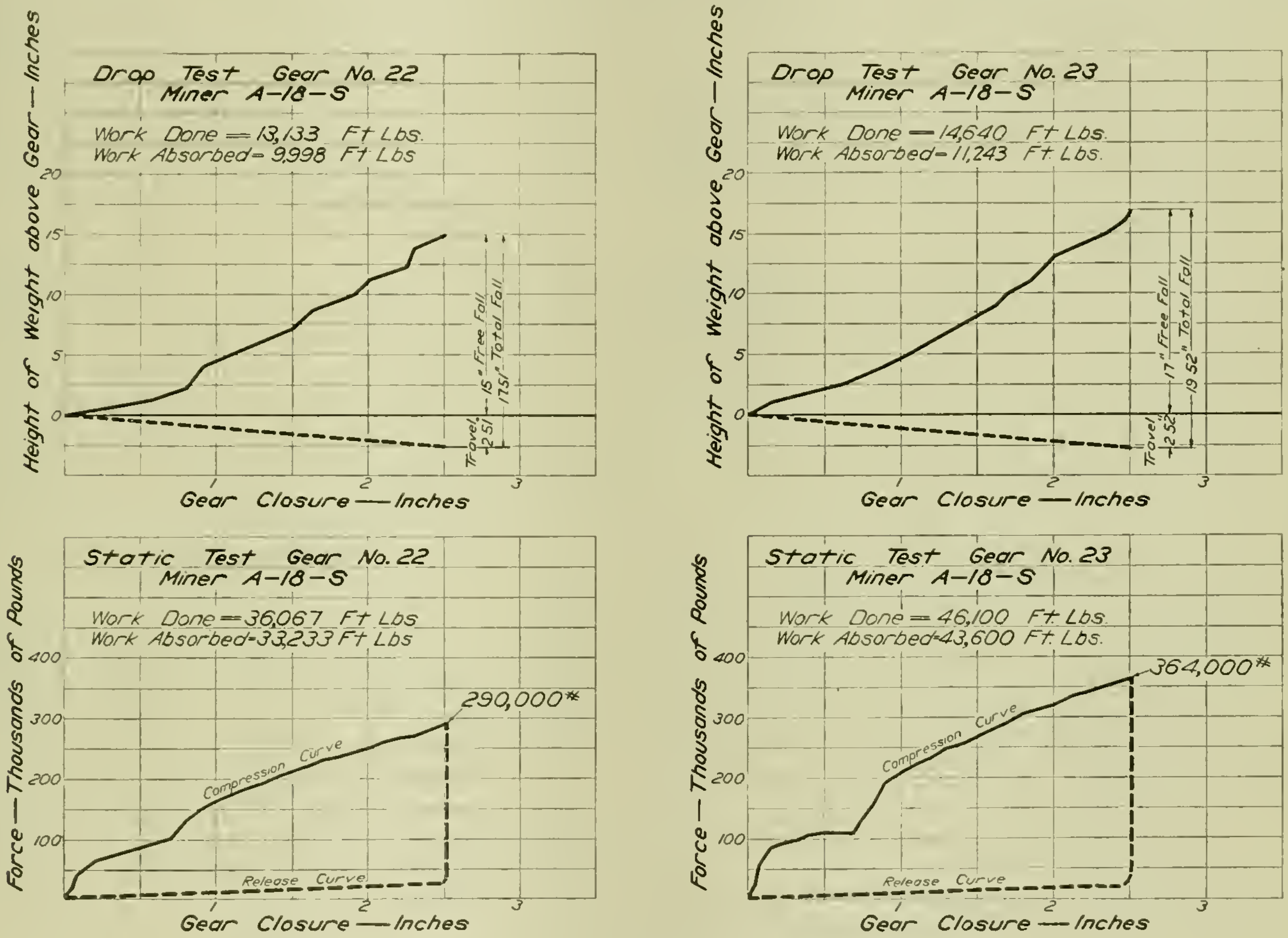


Fig. 2—Typical Drop Test and Static Test Diagrams, Miner A-18-S Gears

The information for plotting drop test diagrams was obtained during the first series of drop tests by causing the tup to drive a nail into the end of a wooden post, the penetration of the nail denoting gear closure for each successive drop. The diagrams have been plotted to the exact points recorded, with no averaging or smoothing up of the curves. The regularity of gear action can thus be seen and in such a test this is of as much, if not more interest than the general trend of the line.

Some of the drop test figures obtained in these tests are higher than usually reported for gears of the same type. The care taken to have all surfaces in good condition and the uniformity of testing conditions insures that the present results are comparable with each other. In general throughout this report the drop tests are reported in terms of "total fall," this being the free fall plus the penetration or actual travel of the gear. Some confusion has existed heretofore in this respect but it is proper to express these results in total fall rather than free fall if the true drop test capacities are to be compared.

The recoil of the 9,000 lb. weight was also measured by means of a special slide on the side of the drop machine. The quantities as tabulated are for the total recoil of the weight above the lowest point reached by it in closing the gear. The drop test capacity, foot pounds of work done, is accordingly represented by the potential energy in the weight at a height corresponding to the total fall required to close the gear. The energy given out by the gear upon release is denoted by the amount of recoil of the weight. The work absorbed is found by subtracting the energy of recoil from the "work done," or the total energy required to close the gear.

A discussion of the individual performance of the gears in the drop test follows:

Westinghouse D-3:—The action of these gears under the drop was entirely satisfactory. The initial flatness of the curves shows the result of the preliminary spring action and the curves as a whole indicate that the gear action is reasonably consistent throughout the entire range. The average total fall of the 9,000 lb. tup required to close a new gear of this type, when in good condition, is taken at 19.8 in., and the total recoil of the weight at 3.8 in. These figures are arrived at by averaging all of the drop test results for these gears, the same practice having been followed for each gear unless a statement to the contrary appears.

Westinghouse NA-1:—The drop test results on these gears are not quite so regular as on the older Westinghouse D-3 gear, but while the diagrams are more irregular, the action in general is good. The results also are considerably higher, hence it cannot be expected to find as regular action as in the lighter gear. No breakage or failure of any kind occurred during these drop tests.

Sessions K:—The drop test diagrams for these gears, while not so smooth, are yet good for a gear of such short travel. In two gears the spring barrels began to scale before the gears went solid. Failure of the gears had, therefore, begun before closure and hence the tests are not satisfactory.

Sessions Jumbo:—This gear showed considerably more capacity and at the same time more uniform action under the drop test than the previous Sessions K gear. The spring barrel of one gear developed a crack during this test.

Cardwell G-25-A:—The action of these gears under the drop was good, the diagrams being especially smooth and regular. The cast iron friction blocks formed decided depressions in the malleable iron heads, however, and a crack developed at one corner of one of the friction blocks, while in the final drop tests at Altoona one of the side friction members was broken in halves. The average drop for the test gears of this type is 21.1 in., but as heretofore explained, it is believed that these test gears are not representative, the average drop test results obtained in United States Railroad Administration acceptance tests being 16.6 in. The gear is, therefore, credited with a value midway between these figures, or 18.9 in. total fall required to close an average new gear when in good condition. The average total recoil to be expected is taken at 2.8 in.

Cardwell G-18-A:—This gear showed smooth and regular action under the drop, and the diagrams are entirely satisfactory. The springs of one gear took a slight set during the drop tests.

Miner A-18-S:—The drop tests of these gears were satisfactory and the diagrams denote especially uniform gear action for all ranges. This is particularly noticeable because of the fact that the gear has a travel of but 2½ in.

Miner A-2-S:—These gears did not show so regular under the drop as the previous Miner gears but the diagrams are good. The drop capacity, however, is low. In one gear the main spring went solid during this test.

National H-1:—This gear developed an unusually high capacity under the drop and while the diagrams are not entirely smooth, yet, considering the amount of fall and the short travel of 2½ in., the gear action is good.

National M-1:—The drop tests of these gears did not produce diagrams proportionally as smooth as those of the previous National gears, considering their lower capacity. The diagrams, however, show reasonably uniform gear action.

National M-4:—The action of this gear under the drop was very similar to that of the National M-1 just described.

Murray H-25:—These gears, while not of high capacity, showed the most regular action of any friction gear tested. The diagrams are unusually smooth and indicate consistent action throughout the full range of the gear. Considerable chafing and wear occurred during the closures under the drop. Unquestionably, this wear would soon deteriorate the gear.

Gould 175:—These gears showed good action under the drop except for the fact that in each instance the plates of the friction spring took a slight permanent set. The gears showed high recoil and because of this feature it was difficult to keep them in position on the anvil.

Bradford K:—The drop testing of these gears was difficult and unsatisfactory. The springs went solid before the heads of the gears came together and two gears failed by splitting the heads. The failures were undoubtedly due to this spring condition, as extremely high forces are set up in this, as in most friction gears, if the springs go solid before the gear is closed. One gear also developed a cracked head during the drop test. It is noticeable that the portion of the head immediately back of the coupler butt, in buffing, is not properly supported. Another serious point is that in several instances the heads pinched and stuck in the frame on release. These gears showed low capacity and high recoil under the drop, their action being very little different from that of a spring gear.

Waugh Plate Type:—These gears gave reasonably smooth diagrams in the drop test but in each instance the plates took a permanent set. The drop capacity is low and the recoil high. The gear is of especially easy movement at the beginning of its travel.

Christy:—This gear was very erratic under the drop, and the action is not at all satisfactory. The gears as tested were shorter than the pocket dimension and this clearance allowed the wedge roller to get out of position upon recoil. The total fall required to close the test gears ranges from 14.3 in. to 26.3 in. It is therefore difficult to set an average value, but in the absence of better uniformity the three results have been averaged.

Harvey 8 in. by 8 in. Springs:—Each of these gears as tested consisted of two Harvey 8 in. by 8 in. springs, set side by side upon the anvil. The gears showed but little capacity under the drop, although the action was regular. In the case of one gear the springs took a slight permanent set.

A. R. A. Class G Springs:—Each of these gears as tested consisted of two A. R. A. Class G springs, set side by side upon the anvil. The springs showed low capacity in the drop test, but the action was smooth throughout the range of the springs. A summary of the data obtained in the drop tests is shown in Table I.

Static Tests

Immediately upon the completion of the drop tests the same two gears of each type were closed in a testing machine at a speed of ⅛ in. per minute. Readings were taken for each 1/10 in. of compression, the closure being continuous, with no stops except where sudden changes in load occurred.

In many gears, when being closed at a slow speed, the resistance will build up at an abnormal rate, and shortly, from some reason such as the elasticity of the parts, a sudden readjustment will occur. In many instances this is accompanied by a loud report that may be best described by use of the word "bombardment." Invariably such readjustment results in a sudden reduction of the load. When a bombardment occurred during the tests, the machine was stopped until a full record of the conditions could be obtained. In plotting the static test diagrams the actual results have been used, all bombardment actions being shown, and no curves having been averaged or smoothed out, as is frequently done in plotting such diagrams. No gear should be condemned, however, solely because of the presence of bombardments or irregular action in the static tests, for some gears, while showing very irregular static diagrams, and even total failure in this slow test will yet show excellent results in both the drop test and the car-impact tests. Bombardments are conceded to be a normal action of many types of gears in slow static testing.

		Static Test Speed of testing machine					Drop test			Car-impact test		
				⅛ in. per minute								
Make and type of gear	Test gear number	3 in. per min. Ultimate resistance, lb.	¾ in per min. Ultimate resistance, lb.	Ultimate resistance, lb.	Work done, ft. lb.	Work absorbed, ft. lb.	Work done, ft. lb.	Work absorbed, ft. lb.	Computed Ultimate resistance, lb.	Work done, ft. lb.	Work absorbed, ft. lb.	Ultimate dynamic resistance, lb.
1	2	3	4	5	6	7	8	9	10	11	12	13
Westinghouse D-3	1	189,000	196,000	190,000	18,434	16,400	13,875	11,100	143,000	....	....	....
	2	207,000	212,000	200,000	18,667	16,534	14,625	11,813	157,000	13,800	11,433	195,000
	3	....	....	....	....	....	16,125	13,253	....	15,533	12,900	240,000
Westinghouse NA-1	4	....	....	Failed	....	....	21,000	....	....	....	....	....
	5	....	....	Failed	....	....	22,500	....	....	....	....	....
	6	....	....	....	....	....	20,295	17,655	....	....	....	....
	7	....	....	....	....	....	19,500	16,875	....	21,417	19,883	158,000
	8	....	....	....	....	....	15,000	12,548	....	16,917	13,550	187,000
Sessions K	9	....	....	Failed	....	....	15,750	....	....	....	....	....
	10	401,000	443,000	395,000	34,700	32,400	13,628	10,793	155,000	....	....	....
	11	....	....	....	....	....	15,045	11,723	....	23,733	20,317	260,000
	12	....	....	....	....	....	13,545	10,605	....	15,000	12,433	165,000
Sessions Jumbo	13	318,000	318,000	318,000	32,300	28,450	19,575	15,803	163,000	....	....	....
	14	504,000	560,000	457,000	61,970	57,000	20,295	16,500	150,000	17,650	13,216	137,000
	15	....	....	....	....	....	23,250	18,420	....	20,400	15,417	250,000
Cardwell G-25-A	16	327,000	381,000	410,000	52,500	51,234	16,313	13,605	128,000	....	....	....
	17	332,000	337,000	356,000	46,600	43,800	15,563	13,373	120,000	16,233	13,100	295,000
	18	....	....	....	....	....	15,563	13,223	....	19,600	17,967	315,000
Cardwell G-18-A	19	234,000	225,000	240,000	32,400	31,300	15,188	13,823	112,000	....	....	....
	20	141,000	135,000	146,000	20,100	18,700	13,718	12,968	100,000	14,033	12,417	110,000
	21	....	....	....	....	....	15,188	14,033	....	20,200	18,733	186,000
Miner A-18-S	22	367,000	383,000	290,000	36,067	33,233	13,133	9,998	106,000	....	....	....
	23	419,000	424,000	364,000	46.100	43,600	14,640	11,243	116,000	22,800	19,167	390,000
	24	....	....	....	....	....	16,898	13,245	....	14,633	7,500	390,000
Miner A-2-S	25	173,000	152,000	146.000	19,500	18,200	10,163	7,290	76,000	....	....	....
	26	344,000	346,000	289,000	49,833	48,033	10,148	7,283	59,000	11,283	9,733	105,000
	27	....	....	....	....	....	9,375	6,533	....	8,767	7,100	68,000
National H-1	28	472,000	330,000	215,000	10,333	7,000	23,648	20,190	492,000	....	....	....
	29	541,000	528,000	600,000	....	....	24,375	20,775	....	25,867	20,500	390,000
	30	....	....	....	....	....	22,125	19.148	....	28,500	21,000	550,000
National M-1	31	487,000	493,000	518,000	43,933	42,067	13,890	11,535	164,000	....	....	....
	32	461,000	414,000	550,000	62,267	58.467	13,898	11,483	122,000	23,033	20,333	400,000
	33	....	....	....	....	....	15,398	12,690	....	16,967	13,234	218,000
National M-4	34	442,000	435,000	358,000*	34,600	32,167	14,655	13,058	....	....	....	....
	35	412,000	387,000	349,000*	28,330	26.300	17,595	14.265	....	20,633	19,283	159,000
	36	....	....	....	....	....	16,148	14,408	....	16,300	12,350	138,000
Murray H-25	37	241,000	242,000	246,000	18.767	16.600	13,238	10,478	174,000	....	....	....
	38	207,000	204,000	206,000	17,500	15,900	12,323	9,795	145,000	14,800	12.867	210,000
	39	....	....	....	....	....	12,603	10,208	....	13.000	10,300	130,000
Gould 175	40	267,000	280,000	253,000	20.700	17,167	13,785	8,025	169,000	....	....	....
	41	261,000	258,000	250,000	19,667	16,934	13,080	7,875	166.000	12,567	8,067	260,000
	42	....	....	....	....	....	13,875	8,408	....	14.967	12,133	230,000
Bradford K	43	....	....	....	....	....	....	....	....	....	....	....
	44	....	....	....	....	....	....	....	....	....	....	....
	45	104,000	101,000	103,000	6.450	2,083	8,588	4,530	137,000	....	....	....
	46	82,000	81,000	85,000	5,367	1,333	6,330	2,438	84,000	7,333	2,883	270,000
	47	....	....	....	....	....	9,330	6,242	....	6,333	1,417	220,000
Waugh Plate	48	187,000	181,000	200,000	9,900	4,967	10,628	4,598	214,000	....	....	....
	49	148,000	144,000	150,000	7.300	3,867	9,938	4.500	204,000	7,767	2,733	335.000
	50	....	....	....	....	....	10,688	4,523	....	10,433	5,500	285,000
Christy	51	194,000	180.000	163,000*	16,300	15,033	10,740	8,228	....	....	....	....
	52	....	....	600,000	....	....	13,658	9,938	....	12,300	10,317	194,000
	53	....	....	....	....	....	19,710	15,308	....	13,567	11,500	150,000
Harvey 2-8 by 8 Spgs	54	364,000	380,000	430,000	10,400	5.400	5.910	3,130	244,000	....	....	....
	55	377,000	361,000	382,000	7,667	4,134	8,070	4,658	402,000	5,900	4,317	245,000
	56	393,000	409,000	458,000	....	....	7,373	4,208	....	4,083	1,100	300,000
Coil Springs 2.8 by 8 Class G	57	....	....	59,000	....	....	4,373	1,253	....	....	....	....
	58	....	....	56,000	3,567	434	4,275	1,215	67,000	3,900	600	60,000
	59	....	....	60,000	4,034	434	4,283	1,200	64,000	4,333	300	60,000

Table II—Comparative Ultimate Resistance of Gears in Static, Drop and Car Impact Tests

The car-impact tests show that when cars are coupled at a velocity of four miles per hour, each of the two opposing draft gears begins to close at a rate of 2112 in. per minute (176 ft. per min.) and that the closing rate gradually falls off until it is zero at the point of maximum gear closure, this corresponding with the point where both cars are of equal velocity. The average rate of closure at four miles per hour impact is approximately 1400 in. per minute; the static test rate of ⅛ in. per minute exists for less than 1/100 in. of gear movement. Results of slow static tests cannot, therefore, be compared with service or impact tests. The static is the simplest and the easiest draft gear test to make, and it is probably understood by the average mechanical man better than any other. It is unfortunate, therefore, that it is not more reliable, but as will be seen as the various tests are discussed, it is usually misleading and cannot be employed for comparing the merits of different draft gears.

The practice of rating gears upon a supposed ultimate resistance such as, for example, "a 200,000 lb. gear" or "a 350,000 lb. gear," is to be discouraged. Due to the limited travel of draft gears it is necessary that the ultimate resistance of the gear be high if cars are to be handled at switching speeds above two miles per hour. The manner in which this ultimate resistance is reached is of great importance. It will be seen in some of the static cards that while the ultimate resistance is high, yet at the beginning of the diagram it is extremely low and becomes really effective only during the last quarter of the diagram. This means not only that the gear is of low capacity for its ultimate resistance, but that the final rate of building up the force is too high and will set up undesirable vibrations in the car structure. The ultimate resistance of a gear cannot, therefore, be wholly indicative either of capacity or of cushioning value, capacity being a product of the average force and travel, and cushioning being dependent upon the rate of building up of the force as well as the magnitude of the force itself.

Static test diagrams were plotted for closures at the rate of ⅛ in. per minute. The same gears were also partially closed at the rate of ¾ in. per minute and at an average rate of 3 in. per minute, for comparison. These three closures were made in immediate succession so that the condition of the gear had not changed.

Because of the fact that the results of static tests are not indicative of the action of the gear under service conditions, the discussion of the individual performance of the gears in the static test, which was included in the report, will be omitted. The results of the tests are given in Table II. For comparison there are shown also the results obtained in the drop test and later in the car-impact tests. Part of this table requires some explanation.

Column 3 gives, for a closing speed averaging 3 in. per minute, the ultimate or maximum resistance of the gear at the point where the gears just closed or where normal gear action ceased. Columns 4 and 5 give the ultimate resistance, at closing speeds of ¾ in. and ⅛ in. per minute. An asterisk (*) in any of these columns denotes that the maximum resistance as tabled was developed before the gear was closed, a bombardment or other cause reducing the resistance at the point of closure. It will be understood that the capacity of the testing machine would not admit of complete closures at the 3 in. and ¾ in. speeds. The results have been extended proportionately, however, so that the tabulated results represent complete gear closures.

Table III—Performance of Gears with Coateo Friction Surfaces (Drop Test)

		Total fall in inches of 9,000 lb. weight to close					
			With coated surfaces				
Make and Type of Gear 1	Test Gear Number 2	In original condition 3	First closure 4	After twelve blows 5	First closure after cleaning surfaces 6	Number of blows required to restore gear to original capacity after cleaning surfaces 7	Remarks 8
Westinghouse D-3	1	18.50	10.50	10.5	11.5	18	
Westinghouse NA-1	6	27.06	13.06	14.06	14.1	41	
Sessions K	10	18.17	8.2	9.2	13.2	15.2 in. after 30 blows	Gear could not be fully restored.
Sessions Jumbo	13	26.10	16.1	16.1	21.1	25.1 in after 35 blows	Gear could not be fully restored.
Cardwell G-25-A	16	21.75	15.75	12.75	18.8	28	
Cardwell G-18-A	19	20.25	13.25	17.00	17.75	30	
Miner A-18-S	22	17.51	11.51	11.51	12.5	40	
Miner A-2-S	25	13.55	7.55	7.55	10.6	27	
National H-1	28	31.53	15.5	17.5	17.5	34	
National M-1	31	18.52	9.52	13.52	13.5	17	
National M-4	34	19.54	8.54	14.50	18.00	4	
Murray H-25	37	17.65	9.7	10.7	11.7	54	No hard coating on surfaces as in other gears, but considerable wear.
Gould 175	40	18.38	11.4	11.4	13.4	52	
Bradford K	45	11.45	9.5	9.5	10.5	11	
Waugh Plate	48	14.17	11.2	11.2	11.2	12.2 in. after 15 blows	Gear could not be fully restored.
Christy	51	14.32	9.3	9.3	10.3	30	
Harvey 2-8 in. by 8 in. springs	54	7.88	5.9	5.9	6.9	13	

Column 10 gives a computed resistance for the drop test. This figure has been obtained by proportioning the resistances to the foot-pounds of work done in these two tests. Thus in gear No. 1, the static test at ⅛ in. per minute gave an ultimate resistance of 190,000 lb. with 18,434 ft. lb. of work done. In the drop test the work done was 13,875 ft. lb.; hence on the same basis the ultimate gear resistance is 143,000 lb. The figures in this column, therefore, although purely hypothetical, are of interest. If the static card is indicative of the dynamic force curve, then the results in Column 10 are approximately correct, for inasmuch as the one leg (gear travel) is the same in both diagrams, the other leg (resistance) should be roughly proportional to the area, or work done.

The resistance figures given in this table represent a variety of speeds and conditions of gear closure, the static closures being at a constant speed and the drop and car-impact closures beginning at a high speed, which gradually reduces to zero at the point of maximum closure. In the car-impact tests, with a gear in each car, the gears begin to close at a speed not less than 1056 in. per minute at two miles per hour impact, or 2112 in. per minute at 4 M.P.H. impact. In the drop test, with a 15 in. free fall, the gears begin to close at a speed of 6458 in. per minute or 9130 in. per minute at 30 in. free fall.

9,000 Lb. Drop Tests—Friction Surfaces Coated with Foreign Material

It has been repeatedly noticed when taking down gears in car repair yards that the friction surfaces, while usually worn to a good bearing contact, are not in the same clean and perfect condition as that of protected test gears. On the contrary, there is frequently found an actual coating or glazing of hard, black material that can sometimes be scraped off with a knife. This is probably an accumulation of particles of metal, coal dust and rust.

In order to obtain some knowledge of the effect of foreign material upon the friction surfaces, one of each type of gear was taken apart, after completing the original drop and static tests, and the friction surfaces were dampened and sprinkled with a mixture of pulverized coal and iron rust. The gears were then reassembled with the parts in their original positions and the dampness allowed to dry out. Each gear was then put under the 9,000 lb. drop and the closing point determined in as few blows as possible, and the gear then given 12 blows at or just below the closing point.

The gear was then taken apart and the free material wiped off with clean waste. In almost every instance the friction faces were now found to be covered with a hard, glazed coating similar to that found in service. This was removed with clean, sharp sandpaper and the surfaces again wiped off with clean waste. This in every instance left the friction surfaces in as perfect looking condition as could be desired. The action of the gears immediately after this is therefore especially interesting, as in almost every case the careful cleaning of the surfaces did not increase the capacity, and quite a number of blows were required to restore the gears to their original capacities. In several instances it was impossible to entirely restore the gears. Any gear might by this method be made to show an extremely low capacity, even though all parts of the gear were of full size and to gage and the friction surfaces apparently in perfect condition. At the same time, an inferior gear could be in apparently no better or more favored condition and yet show decidedly higher results. Table III. has been prepared to show the results of this test.

Car Inspectors and Foremen Propose Changes in Rules

Members Recommend Revisions in Interchange Code for Consideration of A. R. A., Division V.

At a meeting of the Executive Committee of the Chief Interchange Car Inspectors' and Car Foremen's Association of America, held at the Hotel Sherman, Chicago, March 3 and 4, proposed changes in the A. R. A. rules of interchange were taken up, thoroughly discussed and many of them approved for the consideration of the proper committees of the Mechanical Division of the American Railway Association. At the annual meetings of the Executive Committee, held for the purpose of discussing and recommending changes in the interchange rules, it has been customary for members of the Executive Committee only to vote. This meeting, however, was attended by about 100 members of the association, and a motion was adopted that all members be permitted to vote. The meeting was called to order by J. J. Gainey (Southern), chairman of the Executive Committee, who presided at all the sessions.

Elimination of Delivering Line Defects

One of the outstanding features of the meeting was the resolution presented by C. J. Wymer, superintendent car department, C. & E. I., recommending that the rules of interchange be revised to eliminate all delivering line defects, making the owner responsible for all repairs except those due to accident; that the standard prices for labor and material be fixed high enough to afford the repairing line a substantial profit, and a per diem or rental charge be fixed high enough to reimburse the owner for his investment and the cost of maintenance.

Mr. Wymer's resolution, which was offered at the beginning of the first session, after being discussed at length, was revised by a committee, and finally lost by a vote of 32 to 16. The resolution, as revised by the committee, is as follows:

> Whereas, The present interchange code of rules of Mechanical Division V of the A. R. A. in our opinion does not meet present day requirements for handling and maintenance of equipments, and does not sufficiently facilitate the movement of traffic; be it therefore
>
> Resolved, That these rules should be revised, eliminating all delivering line defects, making all necessary repairs chargeable to car owners, except badly damaged cars due to accident on which a limit of repairs chargeable to owners should be provided. A limit to the cost of repairs due to owner's defect should be maintained, owner to advise disposition of car within a specified time, this time to be determined.
>
> Resolved, That the prices for labor and material should be sufficient to afford the repairing line a substantial profit.
>
> Resolved, That if the changes recommended are adopted, the per diem or rental charge should be sufficient to insure the car owner a fair return on investment, which would include interest, taxes, insurance and depreciation. Per diem or rental should include cost of maintenance.

The motion to adopt the resolution was seconded.

A. Herbster (N. Y. C.): This will automatically do away with defect carding. It will eliminate a whole lot of our troubles that we have had in the past. I have not heard anything from Mr. Wymer regarding fire damage, and nothing has been brought up regarding cars being in a flood. On the whole, I think his resolution is a very good one.

A. Kipp (N. Y. O. & W.): It looks to me as if there is altogether too much money involved at the present time to have the railroads of this country adopt any such system. We have not gotten to the point yet where the car owner wants to be, and will be, entirely responsible for the repairs to his cars. Until that time arrives or our equipment is in different shape than it is today, I do not think that a resolution of this kind would be considered by the Arbitration Committee.

F. H. Hanson (N. Y. C.): I think it is a move in the right direction, although probably we are a little hasty in recommending to the extent that Mr. Wymer has suggested. I believe certain modifications should be made in order that our superiors and the Arbitration Committee may sit up and take notice, because there seems to be a tendency now instead of changing a rule now and then each year and making the car owner responsible for more defects to do the pounding all at one time.

J. J. O'Brien (T. R. R. A.): Mr. Wymer, no doubt, has given consideration first to Rule 1, which we all know in the mechanical department no railroad in this country is living up to. Without conforming to that rule, all of the other rules do not fit in. It is very unfortunate that rules which have been gotten up by the Master Car Builders' Association, with good intentions and a spirit to carry them out, cannot be lived up to because of the lack of men and facilities necessary to keep the equipment up.

We have to take another point into consideration. The Car Service Section has formulated rules on the theory that Mechanical Division rules are not going to be conformed with, and, as a result, there is a conflict and always will be. The Car Service Section imagines that all cars are fit for service, and, in reality, approximately 75 per cent are defective and not fit for the commodity for which they were built.

Probably some modification could be made to that resolution, but the intent is good, and it is food for thought for the Arbitration Committee.

C. J. Wymer: It will be observed that the third section of this resolution provides a per diem or rental charge sufficient to protect the car owner which should remove the objection made by some of the members who have spoken. The first section would have the effect of saving an immense amount of stationery, time of car inspectors, time of clerks and time of officers which is required in carrying out the present provisions of our rules and in settling the controversies which arise under them. This labor could be expended in more substantial ways, and the officers, as well as clerks, could give their time to more important duties; the car inspectors could devote their time to repairing more defects and looking for defects which are vital. In interchange the car inspector is more interested in finding the defects which may penalize his railroad with a defect card than he is in finding the things which might cause an accident on your railroad. I believe the inspection should be confined to providing for the safety to train men, safe handling of the equipment and protection to the commodity. No doubt much of the time of inspection could be eliminated. Forces could be reduced because of the time now consumed in making all of these records for protection purposes.

The portion of the resolution relative to the charge for labor and material being sufficient to provide a substantial profit for the repairing line would effect better maintenance of equipment. The owning road would be interested in keeping its cars in repair and thereby preventing the expense which would be involved if repaired on foreign lines. On the other hand, it would be an incentive for the railroad which had a foreign car on its line needing repairs, to make the necessary repairs in order that it might avail itself of the profit. It would also have a tendency to improve the construction of equipment so that it might be maintained at the minimum cost.

The provision for the per diem charge is an absolutely necessary feature in order to protect the company owning the cars. Otherwise there would be no incentive to own cars; it would be profitable to operate with the other man's cars, and it would work a material hardship on the large car owner who would necessarily have to be protected in a regular charge. I brought out in the resolution that the private ownership of cars should be equally protected in the way of return for the use of their money.

A. Kipp: Mr. Wymer speaks of the rental or per diem charge reimbursing the car owner for these repairs that he is going to make the car owner responsible for. At the same time he speaks in his resolution of the price for labor and material, encouraging the foreign line to make repairs. If the per diem is sufficient to take care of all of that for the owner, I cannot see where the incentive is for a road to take its neighbor's car into its shop and thoroughly repair it. While the car is being repaired, the repairing line is paying the owner a rental charge sufficient to take care of any repairs that may be made. Today the roads of the country are pretty generally trying to get rid of the foreign cars on account of that per diem charge. If a road pays that $1.10 per day for 100 or 150 days and then makes $100 or $150 worth of repairs to the car, I can not see where the repairing line is going to get very much out of it.

F. W. Trapnell (Kansas City, Mo.): The railroad without any cars would fare mighty well against one that had a lot of cars. It seems to me in order to go into a deal of this character, it would be necessary to equalize the equipment of the country between all lines. Parts of our country have more business than they have cars to handle, and the roads are using everybody's cars. It seems to me that if everything was made the owner's responsibility and, covered in a per diem charge, it would be hard for those roads to do business.

J. P. Carney (M. & C.): I favor the idea personally, but I think we should go at it more moderately. I think the day is coming when all of the repairs will be thrown into a pool and pro-rated on the basis of the number of cars owned by the different railroads. As a matter of fact, we are all spending a lot of money, and when we get through one hand washes the other if we are honest in the matter. I would be in favor of making everything the owner's defects with the exception of Rule 32.

C. J. Wymer: Mr. Kipp mentioned this incentive. I am not surprised at that point being raised, but the two departments are separate, and I believe the mechanical department would take advantage of the opportunity of repairing cars at a profit. As to the great stock of material, I do not think that affects the matter any more than at present. The change in the rules does not obligate a railroad to carry such stock any more than they do now.

Mr. Trapnell seems to have overlooked the fact that the per diem or rental charge would pertain to large car owners, which I intimated was absolutely necessary to be provided along with this change in the interchange rules.

Mr. Koeneke (Indiahoma Refining Company): What does this committee expect to do with privately owned equipment under a report of this kind. You speak of per diem while a private car moves under mileage.

H. W. L. Porth (Swift & Co.): The resolution embodies the word "rental" which would mean mileage.

The motion to adopt Mr. Wymer's resolution was lost.

M. W. Halbert (Chief Inspector, St. Louis, Mo.): The following recommendation for changes in A. R. A. rules, Mechanical Section III, was adopted at the meeting of the St. Louis Car Foremen's Association on Tuesday, March 1:

Rule 2, Paragraph 2—Change to read as follows:

"Empty cars offered in interchange for loading must be accepted if in safe and serviceable condition, receiving road to be the judge. Owners must receive their own cars when offered home for repairs at any point on their line, and foreign cars previously delivered by them at the points where originally delivered, subject to the provisions of these rules."

Eliminate paragraphs F to G, inclusive.

Reasons: It is felt by an investigation of actual conditions that by placing responsibility for transfer on the receiving line, many less cars will be transferred and more cars will be repaired under load without the necessity for transferring.

Eliminate paragraphs I and J.

Reasons: Unnecessary if recommended change in second paragraph is adopted.

A motion to recommend the proposed changes in Rule 2 was made and seconded.

A. Herbster: The chief joint inspector has this proposition under his thumb. If he does not want a car transferred he makes the receiving line repair. I do not believe the change of this rule will eliminate any transferring.

M. W. Halbert: I am not putting these rules up from the chief inspector's standpoint; I am putting them up for the Car Foremen's Association of St. Louis. The recommendations will eliminate a whole lot of trouble that you are having at large interchange points.

J. P. Carney: I would like to ask what that trouble is.

M. W. Halbert: As long as you pay a man for transferring a car, he can transfer for most any technical defect that could be repaired under this resolution.

J. J. O'Brien: We all know that inspection of cars is not made prior to delivery as it is upon receipt. Every one figures he will pass it to his neighbor regardless of the condition. Penalization has never accomplished anything, and the Master Car Builders, as the years have gone by, have decreased the penalization until they have gotten to the point now that the principal penalization is like Rule 32 and the transfer.

This transfer system in vogue at present has decreased the repairs to equipment and placed the responsibility mostly on the traffic or transportation department. The methods generally pursued of transferring rather than attempting to repair has resulted in less facilities and less men engaged in repairing. If the transfer of cars was placed under the jurisdiction of the mechanical department we know that the mechanical department, before it would transfer a car, would exercise good judgment and repair at least seventy-five per cent of the cars being transferred today. I know of a line that has reduced its transfers by placing them under the Mechanical Department, from fifty to seventy-five per cent. I am heartily in favor of this proposed resolution.

J. P. Carney: I agree with Mr. Halbert, but I believe there ought to be something more in the proposed change. We are paying a lot of money for interchange inspection and supervision that some roads are ignoring entirely. You deliver an empty car that a chief joint inspector says is all right and another road will return it. We have delivered cars for a certain load and have called in an outside party who said the cars were all right and the receiving roads have said they were in bad order and have returned them. We ought to change that rule to read so that we can get the chief joint inspector or his assistants to decide whether that car should be returned to the delivering road.

A. Herbster: If we figure on this change in the rule the A. R. A. will have to change Car Service Rule 14. They are the ones that place the responsibility for cost, not the mechanical department. The mechanical rules only tell us when we can transfer a car, therefore I do not believe that the resolution is in order.

Secretary Elliott: The mechanical division tells us when we can transfer a car and get paid for it, not when we can transfer it. That resolution takes out the feature of getting paid for it. If you want to transfer it, that is your own business.

M. W. Halbert: A great amount of money is expended every year on claims. Every time you transfer a car, no matter what commodity it is loaded with, you have a claim. I have heard it said that there were over $105,000,000 worth of claims paid in 1919. Why not make the necessary repairs if possible and let the car go forward instead of transferring it and getting the claim presented against you, or holding the car up and making the delay?

C. M. Hitch (B. & O.): Nothing has been said so far relative to the loading line loading rotten cars to offer to his connection. When you make the receiving line responsible for the cost of transfer it is more an incentive to cause a bad car to be loaded and imposed on the receiving line than it is to have the delivering line responsible for the transfer. I do not agree with the move to make the receiving line responsible for the cost of transfer; neither do I agree with Mr. Carney's suggestion to change Rule 2 to give the joint inspector sole authority to return empty cars. I believe the A. R. A. will continue to have the receiving line the judge as to what it will accept and run over its railroad.

A. Kipp: I heartily agree with Mr. Hitch so far as the delivering line is responsible for the transfer. Mr. O'Brien said that if the mechanical department was responsible and made to transfer the cars it would make fewer transfers. That is one of the arguments that our operating department put up to the motive power department. After quite a fight they put the transfer of cars over onto the motive power department. We are keeping a very accurate account of the transfers and find now that we are transferring even more cars than we were when the operating department was transferring. The rules strictly specify what defect shall be repaired under load and the A. R. A.'s tell us for what we can transfer and have the delivering line pay the transfer. We should cut down the transfers as low as they can possibly be cut down. That is what we are doing on the road I am with. We are not transferring anything that can be repaired under load, whether it is a reparable defect under load or not. We pay no attention to that whatever. Our foremen all have instructions that if the car can be repaired under load to repair it.

J. J. O'Brien: There should be more cooperation between traffic and mechanical departments. All of the loaded cars originated through traffic and solicitation, on the theory that the cars will move to destination. If the car passes through a territory where they have good facilities and men to keep it in repair, it proceeds. If, however, the car goes along a line where they have no facilities or men, it is transferred. The railroads today are willing to accept freight in a wheelbarrow or by wagon load; when they get it by the car-load, simply because they haven't the facilities to make repairs, they want to transfer.

A. Herbster: I think Mr. O'Brien is putting the mechanical department in the wrong light. We all know that some cars must be transferred because they cannot reasonably be repaired under load, and that will go on as long as the railroads run. But I do not believe any road is doing the transferring on a wholesale order. I know it is not done on any point with which I come in contact. If we come up against a localized condition, that ought to be remedied at the point where it is happening. I cannot see that the change of this rule will change anything.

W. K. Gonnerman (B. & O.): The railroads are equipped at various points to handle the repairs under load. I know we are and I believe each railroad is in the same position. I am opposed to eliminating the penalties for transferring.

P. M. Kilroy: I am in favor of the change recommended by Mr. Halbert: It is true that the matter is under the chief interchange inspectors at all of the large interchange points, but you would be surprised if you were to follow up each one of those points and see just what a variation there is. Every car transferred at the present time is an absolute waste. Even the railroad that gets paid for the transfer is losing money, especially if that railroad is letting their transfers out on contract.

I have tabulated the number of cars transferred at the large interchange points during the last six months of 1920 and it is astounding to see the difference. Some points exceed others by over 2,000 per cent. At one interchange point, I am glad to say there were only forty cars transferred and those forty cars represented twenty-eight different railroads, so the rotten condition of the equipment that has been loaded is not confined to any particular railroad, to any particular section of the country or to any particular type of car. At least one of the cars that was transferred was built during the Railroad Administration period. Out of 25,000 cars interchanged at one point under load, there were 24 transferred. Out of 22,500 interchanged at another large point, there were 40 transferred. Out of 25,000 at another very large interchange point, there were 394 transferred and some 76 or 78 adjustments. They were all handled under the same ruling. The cars moved practically toward the same points. There are a great many railroads at the present time that are transferring cars to save per diem.

At least two cases that came under my observation within the last month will bear repeating. One car was transferred at the St. Louis gateway and the road doing the transferring had to pay a claim of $118 for damage to the freight they transferred. There was another case which you might think was caused by carelessness. The railroad doing the transferring was presented with a claim for $1,550.

If this change proposed by the Car Foremen's Association of St. Louis will make for uniformity and tend to eliminate any of the things that I have mentioned, it is a step in the right direction.

C. M. Hitch: I have had experience where we had so-called repair transfer at receiving line's expense and it did not lessen the transfer at the particular points involved, but increased and encouraged the loading of undesirable equipments. I am not in favor and never have been in favor of imposing on receiving line the cost of transfer for the reason that I do not feel they are transferring cars for fun. I do not see that they make a dollar in transferring cars; it is for the protection of the property at stake.

P. M. Kilroy: Unquestionably nobody wants to tell any railroad what it shall handle. The receiving line should be the judge of what it shall run. But I most certainly do know that transfers are not being made from a safety standpoint only. If you want to go on the ground yourself and look into it, you will know that the transfers are being made on purely technical grounds to avoid the running of the other fellow's cars. Let us assume that the receiving line takes a car and moves it up to one of their repair tracks and they find that the draft bolts are broken. They have either got to transfer that load or apply the draft bolts. If they apply the draft bolts, they get paid for it; the owner is responsible. But doesn't the line handling that car also reimburse for removing and replacing the load to apply the draft bolts? They are sending those cars back at the interchange point and a great many of them are doing this transferring for the reason that they have no facilities for making the repairs and they are taking advantage of the transfer rules to get those cars off their rails.

Mr. Owen (C. I. I., Peoria, Ill.): We have a small interchange at Peoria and we have a special agreement that the receiving line is responsible for repairs that can be made within twenty-four hours of A. R. A. labor. I believe that would be a good thing to incorporate in the A. R. A. rules. We are not having any trouble and we are transferring only for safety.

H. W. L. Porth (Swift & Co.): It seems to me the elimination of paragraphs F to G inclusive is a radical move. Possibly parts of those paragraphs should be eliminated but the elimination, for instance, of the first two clauses of paragraph F would be rather drastic. The elimination of clauses four, five, six and seven will be also.

M. W. Halbert: If the resolution is adopted, of what benefit would paragraphs F to G be? Eliminate the whole business.

C. J. Wymer: The thing I fear in this resolution is the lack of attention given to the condition of cars before loading. We might find that our transfers would increase rather than diminish.

The first sentence in paragraph 2 of the rule is changed by the insertion of "for loading." I do not see that that improves it in the least as they must be accepted now whether they are loaded or empty. This only provides for the acceptance of an empty car for loading and there is nothing said about the car that might not be for loading.

Secretary Elliott: The Car Service Rules take care of the good cars; we are only legislating for the bad order cars. That would be taken care of under the Car Service Rules.

Chairman Gainey: Mr. Hitch says that this allows for the loading of bad order cars and the giving of them to the other men. We are not going to load bad order cars and haul them over your own lines to give them to somebody else. I want you to bear that in mind before you vote. The man that is loading a car is for safety first all of the time if he is living up to what he should do for his country.

C. M. Hitch: I wish that I could feel that all lines would do that, but they do not.

T. P. Carney: There are a lot of roads that get cars that do not want to run a foreign car and they won't do it. If they have a draft bolt broken they call on the chief interchange inspector to give them a transfer and he has to do it under the rules. How can he get out of it?

W. J. Stoll (C. I. I., Toledo, Ohio): In Mr. Halbert's resolution he said that empty cars that have previously been delivered must be received back, subject to the provision of the rules. I do not believe in that. If you give the delivering line a chance to load the cars in bad order, then try to compel the receiving line to run it, he cannot get rid of it until it is empty. I am opposed to that part of the resolution.

P. M. Kilroy: I do not like the insinuation, either implied or direct, that anybody here is going to operate a car over their railroad that is liable to cause an accident. Some of us know that there are a great many transfers that are unnecessary. The railroad that I represent has a record of loading a car and moving it into St. Louis, taking it South, loading it and moving it back as many as five different times and it had five transfers issued against it. I think the car is still running. Would you call that necessary? I am trying to look at this thing from a revenue standpoint.

A. S. Sternberg (Belt Ry. of Chicago): Cars are in bad condition and it is generally conceded that there is occasionally a bad car sent in, but cars placed in industries are inspected very thoroughly. I know they are on our railroad and I believe they are on all railroads in the city of Chicago. None is loaded unless it is fit to carry the load. Why is it that a car will pass over two or three different railroads with a little defect, possibly with a split center sill with draft bolts good. go on another road without any trouble, the defect not being any worse than it was when it originated, and then be transferred against the delivering line? There are a lot of those transfers every day. The change proposed by the Car Foremen's Association of St. Louis will eliminate all such trouble. I believe there are more cars transferred today than during Government control, when the receiving lines did the transferring at their own expense.

A. Kipp: I do not believe that anybody is transferring cars that ought not to be transferred or that are safe to move over their lines. In all of the argument that I have listened to, this condition seems to exist at one particular point and that seems to be St. Louis. I do not see what we have to do with this transfer cost anyway. If we did anything, we should simply modify Rule 2 and say that we can make more repairs under load. The A. R. A. says who will be responsible for the transfer of the load after we tell them what defects we can repair under load. If we have not enumerated enough defects reparable under load, let us add some more.

I move that this resolution be laid on the table until our next regular meeting for discussion.

The motion was seconded.

H. W. L. Porth: There possibly may be trouble, not only in St. Louis, but in a lot of other points where railroads are transferring cars where they have no license to. I personally know that it is being done. But I agree with Mr. Kipp that they should increase rather than decrease the defects that should be repaired under load. If you eliminate paragraph F, aren't you going to decrease rather than increase them?

M. W. Halbert: If the receiving line were responsible for the transferring of the load, of what benefit would paragraphs F to G inclusive be to the receiving line? It is optional with the receiving line to make those repairs or any repairs they can possibly make without the transfer.

Chairman Gainey: I was on a committee for a week that checked up a terminal—every road in that terminal. There were fifty per cent of the cars sent in at the transfer that should not have been transferred. In one of the terminals which I visit, our transfers will run about fifty cars a month, with just as many if not more railroads than another terminal that I visit where we have eight and nine hundred transfers a month. There is something wrong when you get from fifty to nine hundred cars, with more railroads in the terminal with fifty transfers than there are where the nine hundred are transferred.

M. E. Fitzgerald (C. & E. I.): I cannot yet see how any money is going to be saved for the companies by adopting this rule. It will be a matter of education by the representatives of the various lines after you pass the resolution; they will tell their inspectors that we are now responsible for the transfer of cars and they will have to run certain cars because the transfers will not be permitted under the rule. That can be done just as well now. Tell your men that you will not transfer a car for draft bolts or certain other defects. If this resolution is adopted, there is still no instruction in the book to the inspector on what he will do.

The motion to lay on the table was lost.

The motion to adopt the proposed change in Rule 2 was lost.

J. J. O'Brien: I think the right method to use in handling this would be for this body to appoint a committee large enough to be representative of the different sections of the country, to come back this afternoon or tomorrow with recommendations of whatever corrections are necessary in this rule. I do not believe that it is proper to accept that resolution as a whole and present it as the recommendation of this body, but there are very many good points in it and there are some that have not been discussed.

One of them is right in the first paragraph of Rule 2 which outlines the delivery of a foreign car by a railroad to a connecting carrier. That has not been discussed except by Mr. Stoll.

Mr. Owen: The second paragraph of Rule 2 covers the return of cars to the delivering line after transfer or unloading if in the same general condition. If I would deliver you a car and it was necessary to transfer it and you did further damage or smashed the car up, why should I be obliged to take that car back if it is not in the same general condition? My facilities for repairing might not be as good as yours and I believe that the second paragraph of Rule 2 should stand.

On motion, a committee of 14 members was appointed to consider what changes in Rule 2 should be recommended, and report at the afternoon session.

The committee reported unfavorably on the recommendations of the St. Louis Car Foremen's Association, but, by a vote of two to one, with only three members voting, proposed that a limit of 24 man hours be placed on the repairs for which no transfer should be made at the expense of the delivering line.

F. W. Trapnell: The 24 man hours was not to include any of the cast steel parts that had to be repaired, such as bolsters or truck sides. Those will not take any part of the 24 one man hours.

Mr. Jameson (Southern): I would like to know what the committee means by 24 man hours; does it mean on the M. C. B. schedule, or does it mean in a man's judgment that he can repair in 24 hours?

C. M. Hitch: As the motion was put in the committee it was understood that the 24 man hours would be based on Rule 107.

J. J. O'Brien: The object of submitting that proposition to this body was to encourage repairs to equipment and discourage the transfer of cars that could be repaired within a limited time, and it is felt that it is the duty of the mechanical departments of railroads to assist in the movement of traffic by exerting a certain amount of hours in repairs to equipment rather than to transfer, in which they spend more than the ordinary 24 hours.

Mr. Armstrong (C. I. I., Atlanta, Ga.): Who is going to determine whether the car can be repaired within the 24-hour limit? Isn't it going to be left up to the judgment of the men who inspect the cars for transferring?

P. M. Kilroy: I believe any man in the room pretty nearly knows before he starts just how many hours he is going to get under the rules for such work.

President Pendleton: Does Rule 107 allow for repairs? If the car is under load you get an additional charge for removing the load. At points where I have been we did not consider the additional hour; we took the 24 hours as under Rule 107, but did not count the additional hour for removal of the load.

C. M. Hitch: Our chief interchange inspector and his assistants would undoubtedly have to become familiar with Rule 107 to enable him immediately to issue his transfer orders.

M. W. Halbert: We have had the 24-hour clause in effect in St. Louis and we had no trouble in handling it. If a rule like that were adopted now, all you would have to do would be to familiarize yourselves with the working hours and the cost.

A. Herbster: I do not think the proposition is understood as a whole. If I understand this rightly, any car cannot be transferred, or they will not get paid for the transfer, if the repairs consume 24 man hours or less, according to Rule 107. You cannot necessarily repair a car under the load even though the M. C. B. hours are less than 24; then what are you going to do?

A. Kipp: Suppose that it took 30 hours to repair some car and the next car we repaired in 15 hours; one hand washes the other. If you could save the transfer of a car by getting paid for 24 hours labor and you do not lose more than six hours labor on the job, it seems to me that you are ahead of the game with all of the claims that you may expect when cars are transferred. If the commodity in the car is of any particular value, there are not many instances of transfer but what there is a claim made and I believe the railroads would be ahead if they would put in even more than 30 hours.

On motion, the recommendation of the committee was adopted.

F. H. Hanson: I move that the following change in Rule 2, second paragraph, be recommended:

> After the word "defects" in the sixth line, add: "With the exception of cars having defects as enumerated under paragraph F."

The reason for recommending this change is that defects enumerated under paragraph F, Rule 2, tell us what repairs must be made under load. If that car is taken into a yard or shop and is made empty, you can take the same car out and compel the delivering line to accept the car back with those defects that the rules tell you must be repaired under load. We can see no reason why the defects that can be repaired under load should not be repaired by the handling line when the car is made empty, instead of returning it to the delivery line.

The motion was seconded.

M. E. Fitzgerald: You will have to take into consideration paragraphs I and J of Rule 2 which cover the movement of the car that is properly protected by return when empty card. Assume you run a car to its destination, you may return it if it is properly protected by the return when empty card. I think that the entire paragraph referred to in Rule 2 is out of place. It is properly taken care of in I and J.

The motion was lost.

H. W. L. Porth: Going back to paragraph F, article 3, it seems to me that ought to be changed. I think there are a good many trunk lines that pay no attention to that, even now, but this article was put into the rules at a time when cast steel truck bolsters and cast steel truck sides were an innovation. It is a standard or recommended practice now of the American Railway Association. It seems as if cars traveling under loads with defects to truck sides and truck bolsters should be repaired under loads the same as wheels. I move that it be the sense of this Association that article 3 be changed accordingly.

Chairman Gainey: There seems to be no second.

Rules 4 and 32.

Mr. Pellien (Asst. C. I. I., Buffalo, N. Y.): Rule 4, second paragraph and Rule 32, last paragraph, carding of slight damage not requiring shopping of car: In order to bring about uniform handling of defect cards for defects of this nature, this rule should be clarified or the wording modified, as at present it does not seem to be interpreted uniformly throughout the country. The word "immediate" should be placed before the word "shopping" and the words "before reloading" should be changed to "except when loaded." This would bring about uniform handling and would very much clarify the rule, making it read as follows:

> Defect cards shall not be required for any damage so slight that no repairs are required, nor for raked or cornered sheathing, roof boards, fascia, or bent or cornered end sills, not necessitating the immediate shopping of the car except when loaded, the receiving line to be the judge.

I move that that be accepted.

The motion was seconded.

M. E. Fitzgerald: Could that be construed to mean, if you had an opportunity to move a badly damaged foreign car home to the owner over your line—an intermediary line—that it would prohibit you from moving it to the owner and make you assume responsibility to the owner? You would not be entitled to a defect card unless you shopped the car.

Secretary Elliott: In that case you would card the car before you offered it home to the owner.

M. E. Fitzgerald: I must assume that the owner will shop the car, but many cars are not shopped. The cars are being carded and then reloaded. The rule should be changed but not, in my opinion, in the manner suggested.

Mr. Owen (Peoria, Ill.): The rule is not very plain. At our little point we aim to card everything that we figure has got to be renewed. There is a great difference in the judgment of the inspector whether it has to be shopped, whether it will be shopped when it gets on the home line or whether it will be loaded again. Something definite that would be thoroughly understood by inspectors of small points as well as big interchange points should be incorporated in the rule.

M. E. Fitzgerald: There should be a limit stating specifically a certain payment of damage before the car could be carded, or there should be a limit placed on the time in which handling lines would be entitled to collect on a card issued. For example, a car is carded in Chicago under load, moving South. The average car is loaded and unloaded in a certain limited time. That has been figured out. At the expiration of that time if the handling lines have not seen fit to repair that defect or found it necessary, the rule has been violated. The car should never have been carded and that card should be made obsolete. The road handling should assume responsibility.

A. S. Sternberg: There would be a bad order card attached to the car signifying that the car must be placed on the repair track. The hardship that rule brings out is something like this: We will say that the C. & N. W. might deliver a car to the C. & E. I. The latter will deliver it home to St. Louis, and will be penalized because the owner puts it in his shop and repairs it. The C. & E. I. is in no way responsible for the damage. The damage was on the car when it came from the Northwestern. I cannot see that the paragraph in itself is so misleading but there is so much difference in the opinion of car inspectors that it would be better if it were out of the rule entirely.

[An abstract of the remainder of the proceedings will appear in the May issue.—Editor.]

Relative Effect of Time and Service on Car Deterioration

During 1917 a detailed study of the conditions of rolling stock undergoing repairs was made by a western railroad system to determine the relative importance of "time and elements" and actual service as causes for the deterioration of equipment. The study included both passenger cars and freight cars. It was found that 24 per cent of the expenditure for passenger car repairs and 30 per cent of the expenditure for freight car repairs was made necessary by the effects of "time and elements."

Passenger Cars

In making detailed inspections of passenger cars undergoing repairs, the work was divided into two classes, shop and terminal or running repairs. The shop repairs were studied at the principal coach repair shop on the system by actual inspection of the conditions while the cars were undergoing repairs. A total of 83 cars were inspected while going through the shop.

In gathering data for the running repairs, the work done at two of the principal terminal points on the system, was checked during the period of one month at each place. During the two months the actual number of passenger cars receiving repairs at these two terminals was 4,492.

These two independent studies provided sufficient data from which to determine the average relationship of the various sources of deterioration, so far as each class of work was concerned independently. In order to arrive at a proper classification for all repairs it was necessary to determine the ratio of the total cost of running repairs to the total cost of shop repairs. In order to determine this the total annual cost of shop repairs at the three principal shop points where all heavy repairs to passenger cars are made, was subtracted from the total amount of the passenger car repair account. This determined the expenditure for running repairs. Dividing the total amount thus obtained for each of the two classes of repairs by the average cost per car as determined by the detailed studies, figures were determined representing the number of cars receiving each class of repairs. From these data it was determined that 10,452 cars represented the number receiving running repairs to properly balance the total of 83 cars actually checked while undergoing shop repairs. The two classes of repairs were, therefore, combined in this ratio to obtain the proper relationship of the various causes of deterioration in their overall effect.

The causes of deterioration are classified as "time and elements," starting, stopping and switching, and running. This applies fully to the draft gears, trucks and air brakes, but for the body no subdivision is made of the effects of actual service. Thus subdividing all repair expenditures, 24.1 per cent is attributed to "time and elements," 41.4 per cent to the effect of service on the car body, 16.4 per cent is due to running and 18.1 per cent to starting, stopping and switching. Of expenditures for terminal repairs alone, 1.5 per cent are due to "time and elements," 51.3 per cent to the effect of service on the car body, 26.2 per cent to the effect of running and 21 per cent to stopping, starting and switching. "Time and elements" accounts for 37.9 per cent of the cost of shop repairs, the effect of service on the car body for 38.2 per cent, running for 8.6 per cent and starting, stopping and switching for 15.3 per cent.

The table shows in detail the relative effect of these sources of deterioration on various parts of the equipment. Grouped by parts of the equipment, it is found that 64.9 per cent of all repair expenditures are for work done on the car body, 27.6 per cent for draft gear and truck repairs and 7.5 per cent for the air brake. Considering terminal and shop repairs separately, the car body receives 51.6 per cent of the terminal repairs, the draft gears and trucks receive 33.6 per cent and the air brake 14.8 per cent while of the shop repairs the body receives 76 per cent, the draft gears and trucks 21.8 per cent and the air brake 2.2 per cent.

Percentage Distribution of Cost of Passenger Car Repairs to Source of Deterioration

		Terminal repairs	Shop repairs	Weighted totals
Body—				
Inside fittings	Time and elements...	.01	6.80	4.20
	Service	21.60	25.60	21.20
Body proper	Time and elements...	0.25	31.00	19.30
	Service	29.70	12.60	20.20
Draft gear and trucks—				
Running		26.2	8.60	16.40
Time and elements..................		.....	.....	.....
Starting, stopping and switching.......		7.44	13.20	11.20
Air brakes—				
Stopping and switching................		13.6	2.10	6.90
Time and elements.....................		1.2	0.10	0.60
		100.00	100.00	100.00

Freight Cars

The sources of deterioration of freight cars were similarly classified as starting, stopping and switching, running, "time and elements," and loading and unloading, the latter applying only to the car body. The data for freight cars were gathered in the same manner as for passenger cars, the work being done at the principal shop and repair track point. A total of 487 cars was inspected in the proportion of one general, three heavy, seven medium and 38 light. The table shows the detailed classification of expenditures on a percentage basis according to the cause of deterioration, still further subdivided as between the car body, the draft gears and the air brakes. Grouped by causes, 45.7 per cent of all expenditures were required because of the effect of stopping, starting and switching, 17.1 per cent was made necessary by the running of the cars, 30.1 per cent by "time and elements" and 7.1 per cent by loading and unloading. Grouped by parts of the car, 59 per cent of the repairs were made to the body, 9.2 per cent to the draft gears, 26.2 per cent to the trucks and 5.2 per cent to the air brakes.

Percentage Distribution of Cost of Freight Car Repairs to Sources of Deterioration

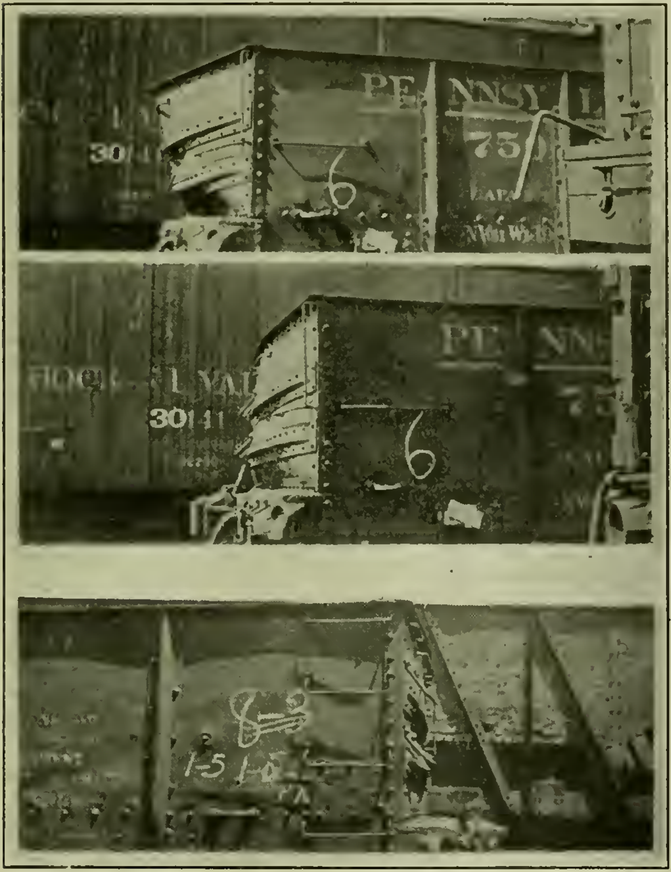
Body—	
Starting, stopping and switching......................	16.8
Running	6.5
Time and elements..................................	28.6
Loading and unloading..............................	7.1
Draft gears—	
Starting, stopping and switching......................	7.9
Running	1.2
Time and elements..................................	0.1

Trucks—	
Starting, stopping and switching	17.5
Running	8.7
Time and elements	0.4
Air brakes—	
Stopping and switching	3.5
Running	0.7
Time and elements	1.0
	100.0

Straightening Car Ends with a Pull Jack

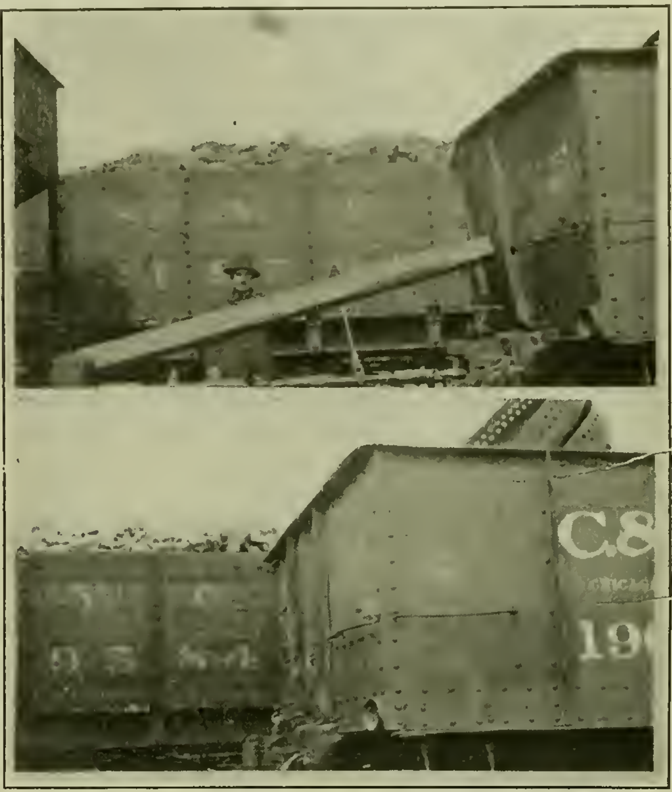
BY A. H. ANDERSON

It is not generally realized that pull jacks furnish a simple and effective means of straightening steel ends without removing them from the car. Where the ends are bulged out so that they interfere with the end clearance or the efficient operation of the brake staff, particularly on cars which have the staff passing through an outside end sill, it is a simple matter to straighten them. This device can also be used for jacking in and fastening the ends on any class of car with wood or composite ends, whether loaded or empty. It is also applicable for trimming loads that are shifted over the end of the car and many other items that are taken care of on the repair tracks.

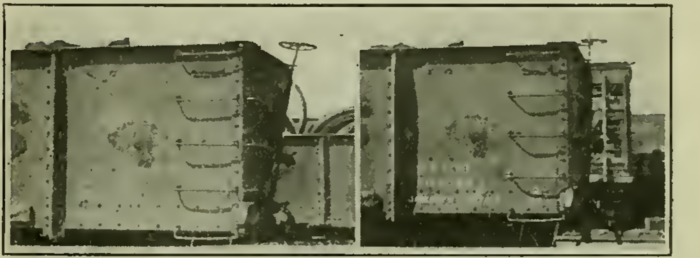

Pull Jacks Facilitate Handling Jobs Such As This

All that is needed for this class of work is a pull jack of ten tons capacity or even lighter. It is convenient to have two jacks for use when a long push is desired. In using the jacks, the knuckles are removed from the couplers on each car and the hooks of the pull jacks are placed around the knuckle pin. An oak timber of good quality, about 6 in. by 6 in., is used for pushing the end of the car, one end of the timber being placed against the bulged end as near the center as possible, or on the end brace if there is one, while the other end rests against the end sill of the other car. If the second car is loaded, the timber may be placed directly against the end. By drawing the pull jacks together, the end is forced back into place. The timber can be reset from time to time on different points until the ends are entirely straightened.

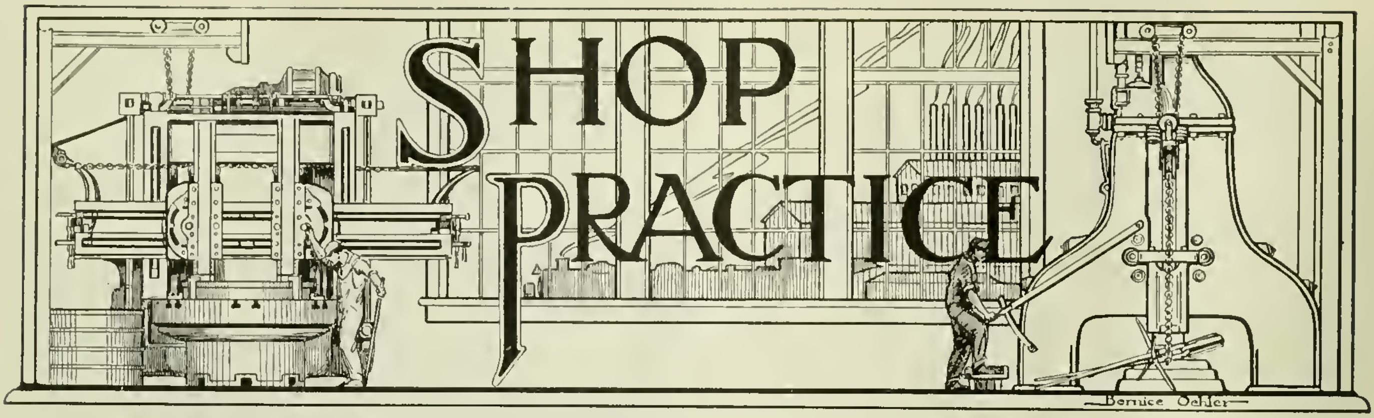
Only two men are required for this class of work. By using a ⅝-in. chain about 10 ft. long with grab hooks on both ends, it is usually possible to avoid pinching cars together and the same length timber can be used for various jobs. This method is especially useful for repairing steel ends at small repair points where there are no facilities for cutting down the parts and riveting them in place again.


A Loaded Gondola Car Straightened Without Shifting the Lading

A few typical jobs done with this equipment are shown in the illustrations. The car in Fig. 1 was loaded with steel bars, 30 ft. long, to within 18 in. of the top. The lading was against the end of the car. By the use of the pull jack, the end was straightened to the position shown in the second view, when it was necessary to shift the load with an engine. The third view shows the end completely straightened after shifting the load. The total time required for this job was six hours for two men.


A Bulged End Repaired by Two Men in 20 Minutes

The second car shown carried a load of tank heads, 10 ft. in diameter, which were resting against the end. As shown, the end was bulged out 1 ft. at the top. The lading was pushed back as the end was straightened and all work on the car was completed by two men in 30 minutes. The third illustration shows another typical job of straightening, this being completed by two men in only 20 minutes.



Progressive Failure or Fatigue of Metals Under Repeated Stress*

BY H. F. MOORE†

If a freight car axle is subjected to a heavy overload, the ductility of the steel of which it is made allows it to bend. The axle is distorted, but actual rupture of the metal will not take place. Consider now the case when the loaded freight car is running. For every revolution of the wheels there is on every longitudinal fibre of the axle a complete reversal from tension, pulling action, to compression, crushing action. If failure occurs after the car has run many thousand miles, the action is entirely different from the bending action under a single heavy overload. Almost without warning the car axle snaps short off, and the steel behaves as if it were a brittle material rather than a ductile material. Such sudden failure under repeated loading is said to be due to the fatigue of metals, and occasionally occurs in shafting, automobile parts, airplane parts, wire ropes, band-saws, steam and gas engine parts, and other parts of rapidly moving machinery.

The Foreman and His Outlook

You are working for a large organization. You have jurisdiction over one comparatively small section of one of the several departments of that organization.

What do you know about your road—its extent, its policies, its financial condition, its operating problems, its traffic interests, its relations to the public, etc., etc.?

You say these things do not concern you! Are you sure of this? How can you co-operate intelligently with other departments if you know so little about the railroad as a whole?

Your department is not isolated; it is not an end in itself. It is one small member of the greater body all of whose parts must work in harmony and unison if effective work is to be done.

Explanations of Fatigue Failures

The apparent change in the nature of metal which fails under repeated stress gave rise to the theory that under repeated stress some profound change took place in the very nature of metal, changing ductile to brittle metal. This change was spoken of as crystallization, and it was supposed that under repeated stress, metal changed its structure from fibrous to crystalline, and as evidence the sharp crystal appearance in the fracture under repeated stress was brought forward.

In the latter years of the last century, various metallurgists began to use the microscope as a means of studying the internal structure of metals, and their work, especially that of the English metallurgists Ewing, Rosenhain and Humfrey, showed that the structure of metals is always crystalline either before or after repeated applications of load. They showed that the fracture under repeated stress was due to the spread of minute cracks, called by them slip lines, which extended completely through the crystals of the metal and which, spreading and uniting into large cracks, acted similar to minute hacksaw cuts, gradually reducing the cross section of a machine part until it could no longer carry its load and suddenly snapped off, very much as a piece of iron falls off when cut almost in two by a power hacksaw.

The starting point for one of these minute slip lines may well be some point in the metal where a minute flaw exists, either in the shape of a flaw within the metal, or in the shape of a notch or sharp scratch on the surface. We think commonly that our mathematical formulas for figuring the strength of machine parts are exact, because they involve exact mathematical processes; as a matter of fact these formulas neglect thousands of minute actions which tend to destroy material. For example, they take no account of a cutting action where a shaft rests on the edge of a bearing. Under a single load, these minute actions are of no importance; their effect is so localized that no appreciable effect is produced on the deflection of a piece. If, however, the loading is repeated thousands or millions of times, then such a microscopic cutting action may start a crack, which under repeated stress will spread to causing final failure.

Any sharp discontinuity in metal, due either to a surface defect or to an internal flaw, greatly increases the stress in the metal over a microscopic area around it. This fact has been verified both by experiment and by mathematical analysis. As an example, it may be cited that the localized stress at the edge of a rivet hole may be as high as three times an average internal stress in the metal of a plate; the stress near the bottom of a sharp notch may be five or six times as high as a stress a few hundredths of an inch away from the notch. At the danger of wearisome repetition it seems worth while again to emphasize that these localized stresses are of negligible account for structural and machine parts subjected to few loadings, but may be of the greatest importance

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*A paper prepared under the auspices of the Engineering Foundation, the National Research Council, the General Electric Company, Schenectady, N. Y., and the University of Illinois Engineering Experiment Station, Champaign, Ill.

†Professor of engineering materials, University of Illinois, Champaign, Ill., and in charge of joint investigation of fatigue of metals.

in the case of parts subjected to many thousands of loadings.

The problem of the designer and the metallurgist is to determine limiting conditions so that this progressive failure will not occur. The usual method is to make sure that no fiber in any part of a machine member is loaded beyond the elastic limit of the material by any load which will come upon it. The difficulty of applying this rule is twofold. In the first place, the determination of the true elastic limit of metal is a matter of a great deal of uncertainty. Delicate methods of measurement of stretch and careful methods of computation give an elastic limit lower, sometimes much lower than the value given by the ordinary commercial test. Some doubt exists as to whether actual material is perfectly elastic under any stress, no matter how small that stress is. Here again it should be noted that a slight inelastic action is of no account for a structure loaded but a few times. But under load repeated many thousands of times any damage due to slight inelastic action is cumulative and actually may cause final failure. In the second place it practically is impossible to figure all the small localized stresses in a machine member, especially in an irregularly shaped machine member. Sharp shoulders or notches may cause localized stresses many times those which would be given by the ordinary formulas of mechanics.

This progressive spread of small cracks is offered as an explanation of the occasional failure of springs while under the action of light loads. At some time in its history a spring is subjected to a few heavy loads. These heavy loads start microscopic cracks and are not repeated often enough to cause them to spread far. However, these microscopic cracks are in themselves very sharp notches, and cause high localized stress under subsequent light loads with consequent spreading of the cracks and final failure. For a machine part subjected to repeated stress it may be necessary to know its history as well as the properties of the material in order to judge of its safety.

Machine for Making Fatigue Tests

At the present time the most satisfactory method to determine the ability of material to resist repeated stress is to make actual tests of it under a great many repetitions. Over a year ago the joint investigation of fatigue of metals was organized by the National Research Council under the auspices of the Engineering Foundation, University of Illinois Experiment Station, and National Research Council and was given as its main problem, the study of the behavior of a number of common kinds of steel under repeated stress. Tests are carried for several specimens of each kind of steel to one hundred million complete reversals of stress.

The machine used for the greater part of the testing is, in principle, a car axle placed upside down. A circular specimen rotates in bearings and is driven by a motor; weights are hung on it at two symmetrical points along its length. The bearings used are all ball bearing so that friction is reduced to a minimum. The suspended weights set up bending in the specimen; compression along the top side of the specimen and tension along the bottom. When the specimen rotates 180 degrees, any given longitudinal fiber changes from compression to tension, a complete reversal of stress. A revolution counter gives the number of cycles of stress. The machine runs at 1,500 revolutions per minute and operates day and night. A battery of 15 such machines now is in operation. In testing any kind of steel or other metal, tests are made on such a machine, using various weights. In this manner the number of reversals required to cause rupture is noted. It is found that there seems to be a fairly sharp limit of stress below which failure does not occur at one hundred million repetitions. Moreover, a curve plotted with stress as ordinates and numbers of repetitions for failure abscissas seems to be horizontal for this limiting stress. This stress is called the endurance limit of the metal, and is considered an index of the ability of the metal to resist repeated stress.

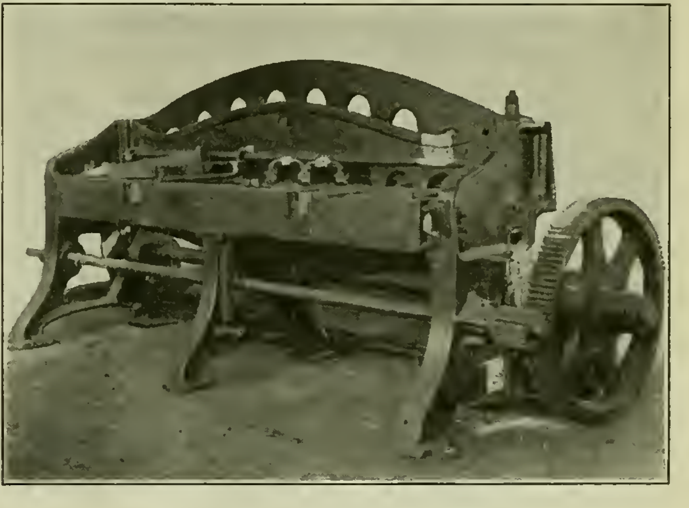
Factors in Fatigue Resisting Strength of Metals

The quantitative statement of factors affecting the fatigue resisting strength of a metal cannot be given at this time, but certain qualitative indications may be noted. Those fatigue resisting strength of metal depends upon: (1) Its elastic strength; (2) its ductility; (3) probably the amount of initial stress left in it by heat treatment; and (4) its homogeneity of structure. Possibly still other factors enter. It is evident that high elastic strength would tend to increase the fatigue resisting qualities of a metal. The effect of ductility may be explained by the fact that at a small flaw in a piece of ductile material some stretching would be found with a consequent tendency to distribute the stress over more material than in the case of a brittle material. Initial stress would, of course, tend to start microflaws when a slight additional working stress was given. It might be noted that if an ordinary testing machine test is made of a piece of steel containing initial stress, the measurement of stretch would be taken over a considerable length of the specimen and there would be a tendency for the positive and negative initial stresses present at different parts of the cross section to neutralize each other and thus to mask the first point of yielding of the specimen. This neutralizing tendency would not, however, prevent any initial stress from starting a crack when it was reinforced by a slight additional working stress. Inhomogeneity of a material is a source of weakness under repeated stress in that it permits the stresses to break down, because of the already started microflaws.

Probably many cases of fatigue failure of machine parts are blamed on the material used, when they should have been blamed on the shape of the piece or on the surface finish. In conclusion, it is desired again to call attention to the great danger of starting microflaws at the root of sharp shoulders, notches, or rough tool marks on a piece. Good surface finish and generous fillets at shoulders are vitally necessary in a design of parts to be subjected to repeated stress.

Wrecked Shear Reclaimed by Oxy-Acetylene Welding

The $3,000 metal shear shown in the illustration was broken in thirteen different places. In common parlance it was a "total wreck," and not many years ago would have been worthless except for a nominal value as scrap. In this day of modern welding, however, broken machinery of all



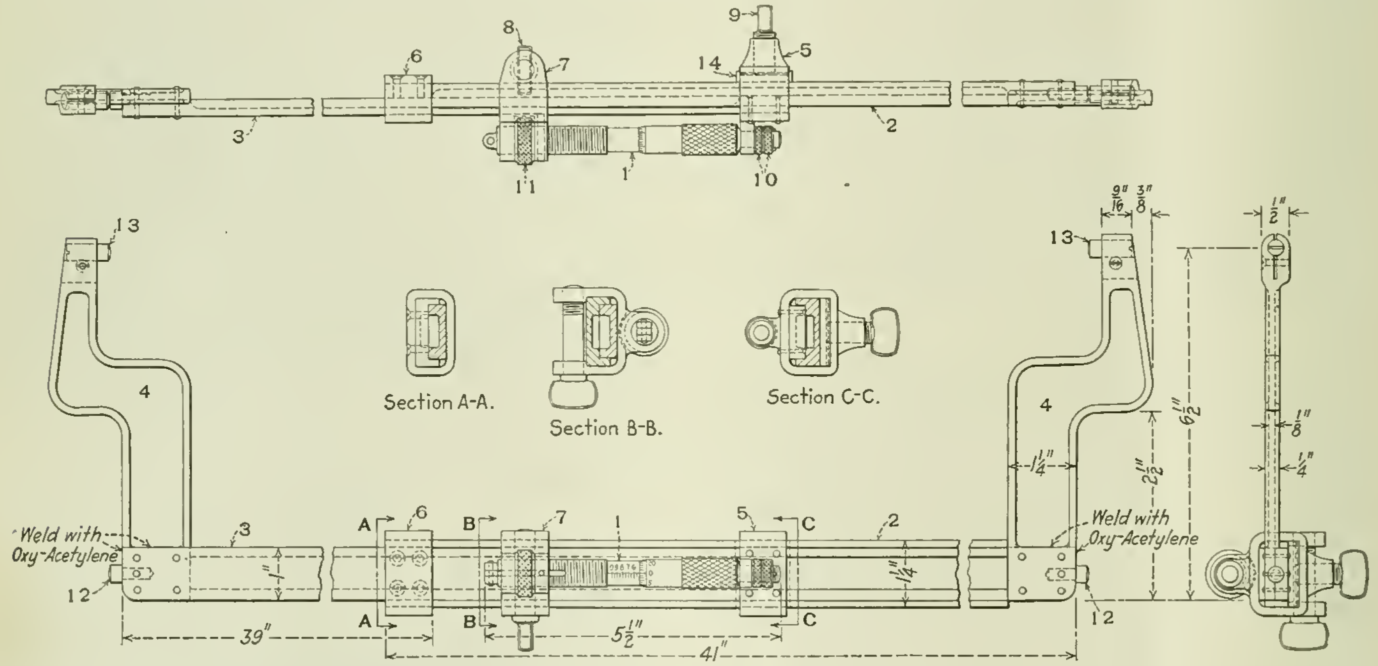
Heavy Shear Repaired by Welding

kinds can be repaired so cheaply and satisfactorily that the first thought is always for reclamation. In this instance the big shear was repaired by welding by the Oxweld Acetylene Company, Newark, N. J. No unusual features were encountered, and the job is cited only as being typical of what has now become everyday welding practice.

Gage for Calipering Driving Wheels and Tires

BY E. A. MILLER

For the accurate calipering of driving wheel tires, wheel centers and particularly the inside diameters of tires when allowing for shrinkage fits the gage illustrated has demonstrated its value. The frame of the gage is made in two parts sliding on each other, the micrometer *1* being provided to adjust the gage the required number of thousandths allowed for tire shrinkage. Parts *2* and *3* are made of axle steel to the dimensions shown, each being milled on one side to reduce the weight of the gage and provide stiffness. Part *3* is accurately planed to slide in part *2* without side motion. Two, offset, drop forged arms *4* are provided, one being riveted to part *2* and the other to part *3*. These arms are rigidly held against rocking by ⅛ in. tapered rivets in reamed holes.



Inside and Outside Driving Wheel Tire Callipers

Parts *5* and *6* are made of brass and act simply as guides for the ends of parts *3* and *2* respectively, being held in place by four ⅛-in. machine screws each. Part *5* is provided with a gib *14*, which slides along *2* and a thumb screw *9* for tightening the gage. The lug projecting on the side opposite the thumb screw is drilled to receive the 5/16-in. threaded end of the micrometer. There are two knurled, 5/16-in. nuts *10* on the end of the micrometer, a small pin preventing danger of loosening.

Part *7* is also made of brass and fits over parts *2* and *3* as is perhaps best shown in section *BB*. The thumb screw *8* is used to tighten part *7*. A ⅜-in. slot in *7* is arranged to receive the knurled nut *11* which turns on the ½-in. threaded end of the micrometer, as shown. This ½-in. end of the micrometer is split, as shown in the lower view and a ⅛-in. pin prevents turning when the knurled nut is turned. Before being split, the end of the micrometer is turned down to ⅜ in. and drilled for a 1/16-in. rivet which is applied after the gage is assembled. This prevents the knurled nut *11* from working off in use or due to any accidental turning.

Two contact points *12* which form the inside calipers are made of hardened tool steel, shaped as indicated, and turned into ¼-in. threaded holes in the respective ends of the gage. It will be observed that after the contact or gage points *12* were applied, a ⅛-in. tapered rivet was put through each to hold it against the possibility of working out. Contact or gage points *13* also are made of hardened tool steel, held in the drop forged arms *4* and forming the outside calipers. Contact points *13* are threaded and adjustable in or out, being held firmly in any desired position by means of the ⅛-in. machine screws shown.

Before proceeding to use this gage it is absolutely essential that contact points *13* be adjusted until the distance between them is exactly equal to the distance between contact points *12*. Should it be desired to bore a driving wheel tire for application to a wheel center and making the necessary allowance for shrinkage, the wheel center will first be calipered, using contact points *13*. With thumb screws *8* and *9* loose, the gage is adjusted to the approximate diameter of the wheel center. Tightening thumb screw *8*, adjustments can be made by turning nut *11* and fine adjustments by turning the micrometer sleeve. This will give the correct diameter of the wheel center. By means of the micrometer, contact points *13* can then be brought together the required numbers of thousandths allowed for shrinkage, tightening the thumb screw *9* which holds the two parts of the gage firmly together. But the distance between contact points *13* has already been adjusted equal to the distance between contact points *12*. Therefore, these latter points may be used as the inside calipers to which the tire should be turned.

Contacts points *13* can, of course, be used as outside calipers for calipering driving wheel tires whenever this may be necessary. In turning a wheel center to fit a tire which has already been bored, the operation described above is simply reversed. It is particularly important that the drop forged arms be immovable on the gage frame and as an additional precaution it has been considered best to provide oxy-acetylene welded fillets, as shown. The construction of this gage requires considerable time and accurate workmanship which, however, will be repaid many times over by the more accurate fitting of tires to driving wheel centers and the resultant elimination of trouble due to tires working loose.

A Locomotive Repair Shop Scheduling System

Foremen Are Relieved of Details and Shop Output Is Increased by Applying the Locomotive Schedule in Railroad Shops

BY GRANT GIBSON

LACK of progress in systematizing work in railroad repair shops is often due to failure on the part of mechanical department supervisors from gang foremen to superintendents of motive power to appreciate records and shop schedule systems. This is a rather pointed statement, but nevertheless true. The lack of appreciation of the man trained to keep records is ever present among railroad men and until such time as shop supervisors recognize the value of records in marking progress, warning of past mistakes and indicating possible future improvements, one avenue of increased shop output will remain closed.

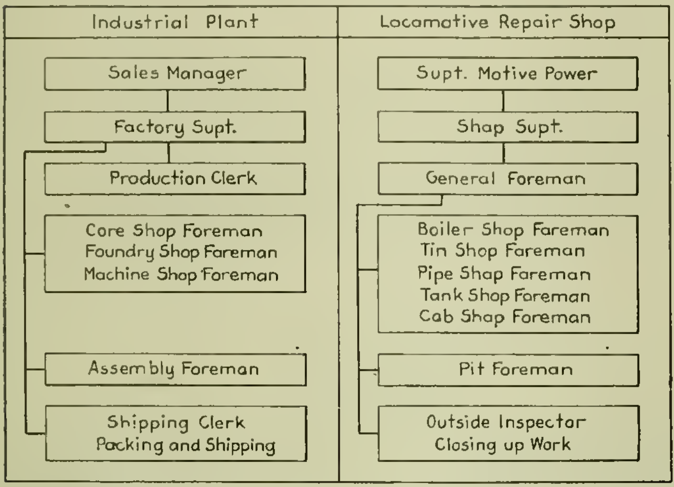


Fig. 1—Chart Showing Comparative Organizations. The Parallel Is Not Complete Until a Production Clerk Is Added Under the General Foreman

One of the thoughts that first came to the writer upon undertaking industrial work (after fifteen years in railroad mechanical departments) was the similarity of railroad and industrial organizations and four years as superintendent of a manufacturing plant has served to make this thought sink deeper. There is absolutely no reason why the same systems that have increased the efficiency of manufacturing plants should not provide greater railroad repair shop output. The contention that "due to the diversity of railroad work" these systems cannot be installed is prejudiced error; they can and will eventually be installed. What railroad shop has a wider diversity of work than exists in the plants of the International Harvester Company for example? This company repairs and builds a thousand types of machines; the average railroad may have fifteen or twenty types of locomotives.

The shop man should realize the similarity in organization referred to which is plainly shown in Fig. 1. The dissimilarity lies in the fact that the manufacturing plant has a production clerk to route and follow up the work while in most cases the railroads use their general foremen for this purpose. Put a production man under each general foreman—a man who will follow the work through—and the general, shop and gang foremen will have a great deal more time to plan department work and install improved methods.

An editorial entitled, "Systematizing Management in Railroad Shops," which appears in the November issue of the *Railway Mechanical Engineer*, incorporates three important factors in shop output:

1. Time Study.
2. Cost Records and Accounting.
3. Shop Scheduling and Follow-Up System.

The time study and cost records are really secondary in importance to the third factor, shop schedule and follow-up system, and it is the object of the writer to describe briefly in this article a method that will systematize railroad repair work, relieve the foremen of details and provide considerable increases in shop output.

Simplicity must be the keynote as any system involving an army of clerks is top-heavy and liable to break under its own weight. While there is a decided lack of system in the handling of repairs to passenger and freight cars, it is not as apparent as with locomotives, therefore, this article will be confined to the scheduling of locomotive repairs.

Duties and Records of Engine Clerk

The engine clerk of the superintendent of motive power is the chief dispatcher of locomotive repairs. His duties are to maintain all locomotive records including mileage, assignment, cost of maintenance, etc. The mileage is reported to him by the general superintendent of transportation; the cost of repairs by the shop superintendent or master mechanic. Form 1 is suggested for the purpose of maintaining this record. Incorporated therein are all the essentials, the left side of the form reflecting repairs and the right the miles made on the various divisions. One card is provided for each locomotive and is made to cover a three-year period.

Engine Number

FORM 1

Division to which Assigned	Shop	Class of Repairs	Cost	Date In	Date Out	Total Miles	Month	Locomotive Mileage By Divisons								
								Division #1	Division #2	Division #3	Division #4	Division #5	Division #6	Division #7	Division #8	Division #9
							19__									
							Jan.									
							Feb.									
							Mar.									

Form 1, Showing Mileage and Locomotive Repair Data

It is poor policy to wait for a locomotive to go to pieces before repairing it and the practice should be to schedule the repairs according to mileage except in the case of wrecks. In applying the new system, the superintendent of motive power should first take into consideration the condition of power, right-of-way, past performance of the locomotives in passenger, freight, switch and work train service, arbitrarily setting up a maximum mileage between repairs for these classes, as for example:

Passenger locomotives, 120,000 miles.
Freight locomotives, 85,000 miles.
Switch locomotives, 65,000 miles.
Work-train locomotives, 70,000 miles.

Form 2.

———————1920.

Mr.——————
Shop Sup't.,
Master Mechanic——————

Dear Sir:

According to my records, Engine ———— is due for {heavy / light} repairs ———— 1920. This locomotive has made ———— miles since last heavy repairs and ———— miles since last light repairs. You will find attached hereto, for your guidance Form 3, describing in detail these repairs.

You will arrange for immediate inspection of this locomotive, to determine what repairs are necessary. Give your storekeeper a list of material needed in order that he may have same on hand when engine is held. (If engine is to be sent to another shop for repairs forward this information to the Master Mechanic or Shop Sup't in charge in order that he may have an opportunity to get his material together.)

This engine is to be repaired in ———— Shop and upon completion of repairs, Form 3 should be sent me giving in detail all repairs made and the cost.

Yours truly,
——————
Supt. Motive Power.

……………………………………………

Mr.——————
General Foreman.

Dear Sir:

Please note the above and with return of this communication filled out in every detail please send me Form 5.

You may retain Form 3 for your guidance.

Yours truly,
——————
Shop Supt.—Master Mechanic.

Form 2 is Sent Out by the Engine Clerk

FORM 3.

Details Of Repairs To Locomotive ________ At ________

Part	O New X Rep'd	No. Pieces	Remarks	Part	O New X Rep'd	No. Pieces	Remarks
ENGINE FRAME				RODS			
Frame Right				Main Rod Brass R.or L. F.or B			
Frame Left				Main Rod Strap R.or L. F.or B			
Front Deck				Side Rod Front R.or L.			
Brasses				Retaing Rings or Segments			
Cellars				Axle (kind of material)			

Form 3 of Which a Part Is Here Illustrated, Includes Additional Details Under the Heads Engine Truck, Driving Wheels, Trailing Wheels, Tank, Tender, Frame and Truck, Cab and Pilot, Air Brake, Air Signal, Painting, Steam Chest, Cylinders, Valve Gear, Power Reverse Gear, Pistons, Boiler, Firebox, Smokebox, Grates, Staybolts, Flues, Superheater, Steam Pipes, Brass Work and Miscellaneous

Locomotive ________

Repaired At ________ Date In ________ Date Out ________ Class of Repairs ________

Department	Estimate						Actual						Over		Under	
	Labor		Material		Total		Labor		Material		Total					
Machine Shop																
Boiler Shop																
Blacksmith Shop																
Tin Shop																
Tender Shop																
Cab Shop																
Total																
General Overhead																
Grand Total																

MONEYS EXPENDED DUE TO ACCIDENT:-

Labor		
Material		
Total		
Grand Overhead		
Grand Total		

Cause of Over-run:-

Summary Appearing on the Back of Form 3

The next step is to determine the length of time required to segregate in the storehouse the materials needed for repairs. It would be ideal if the stores department could carry sufficient stock at all times to protect itself, but this is impracticable from a financial standpoint. Assume that two months is required for this segregation of material. Two and one-half months before an engine is due for repairs, the engine clerk sends out Form 2.

The time for sending out Form 2 is readily determined by subtracting from the maximum desired locomotive mileage between shoppings, two and one-half times the average monthly mileage. Form 2 is two-fold, the upper half being directed to the shop superintendent or master mechanic and the lower half to the general foreman. Form 2 is accompanied by Form No. 3, "Details of Repairs," which will be explained later.

Upon receipt of Form 2 at the shop the figures shown thereon are transferred to the upper parts of six forms, 4a, b, c, d, e, and f, covering detailed work in the boiler, machine, blacksmith, tin, pipe and tender shops respectively. Partial Form 4a, as illustrated for the boiler shop, is typical of the others.

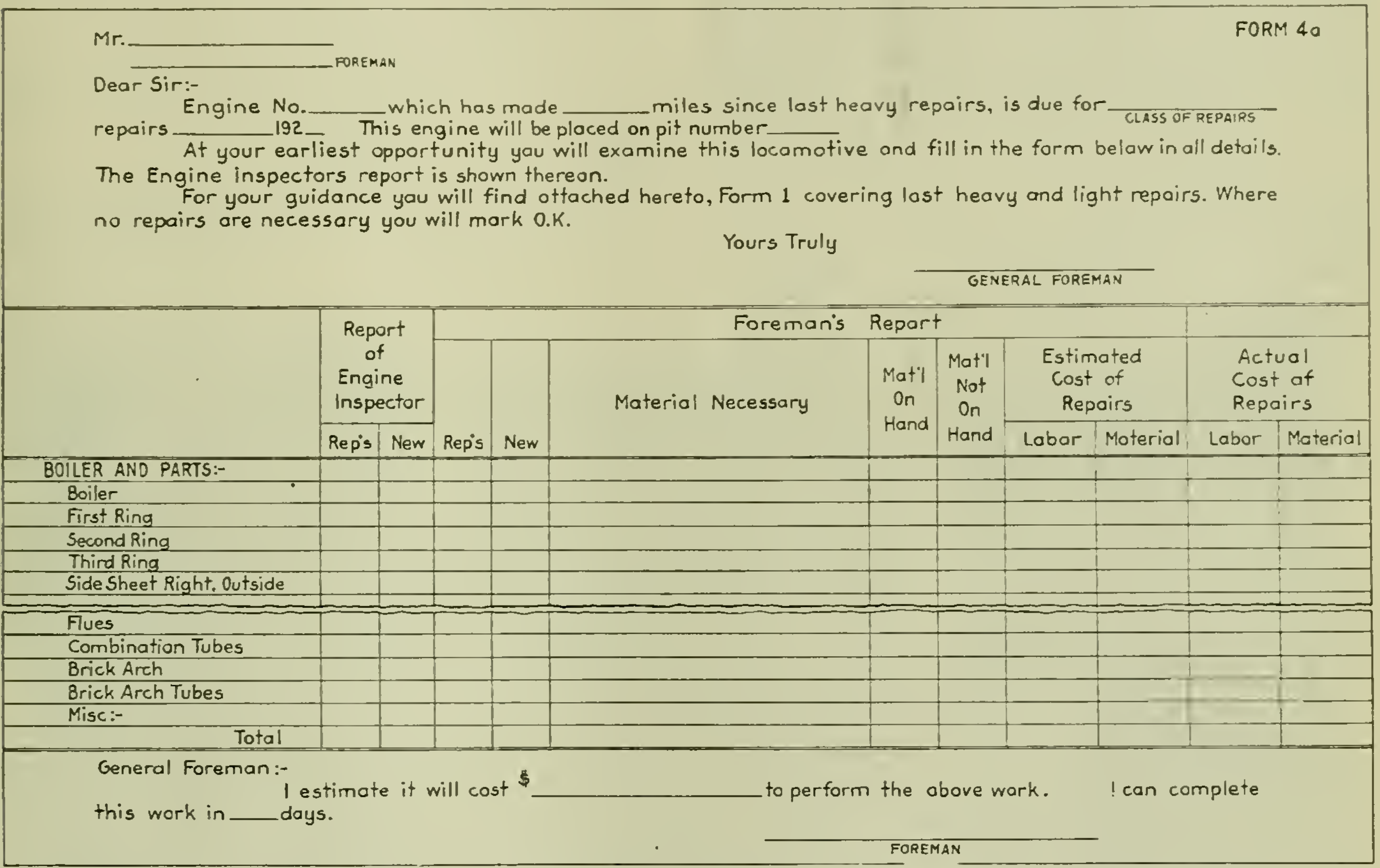
To allow for carbon copies, two each of Forms 4 are turned over to the roundhouse engine inspectors (boiler and machinery) who fill in the column "Report of Engine Inspector," after they have looked over the locomotive. They will report the repairs or replacements which develop under their observation and this information is a guide to the shop foreman who subsequently makes a more thorough examination. After the engine inspectors complete their report, the forms are returned to the general foreman, who gives them to his respective department heads. The general foreman also arranges with the roundhouse foreman to hold the engine for a thorough inspection, this being two and one-half months before the shopping is due. The roundhouse foreman knocks out the fire at the first opportunity and advises the several foremen when they may inspect.

The shop foremen (with engine inspectors if necessary) make an examination and very carefully fill in the several columns on Forms 4 under the heading "Foreman's Report."

Extreme care should be exercised by foremen in filling in the "Foreman's Report" as it is through this medium that the production clerk gets his line-up for scheduling. If, for example, the boiler shop foreman shows on the form that the front tube sheet merely needs repairs and subsequently it is discovered that a new sheet is needed, considerable delay will be incurred if there is no material on hand with which to make up the sheet.

Estimated and Actual Repair Costs

It will be noted that two columns are provided on Form 4a covering "Estimated Cost of Repairs" and "Actual Cost of Repairs." The sole idea in having the foreman fill in the first is to actually commit him as to the probable cost. If he declares the work will cost $8,000, he will make an effort to come within that amount. The production clerk will procure from the accounting department the actual cost of repairs after their completion and the discrepancies should be called to the foreman's attention by the general foreman. Each foreman, upon completion of his report, will sign in the space below and return one copy to the general foreman, retaining one for his file.



Mr.________ FORM 4a

________FOREMAN

Dear Sir:-

Engine No.______which has made ______miles since last heavy repairs, is due for ________ CLASS OF REPAIRS repairs______192__ This engine will be placed on pit number______

At your earliest opportunity you will examine this locomotive and fill in the form below in all details. The Engine Inspectors report is shown thereon.

For your guidance you will find attached hereto, Form 1 covering last heavy and light repairs. Where no repairs are necessary you will mark O.K.

Yours Truly

____
GENERAL FOREMAN

	Report of Engine Inspector		Foreman's Report								
					Material Necessary	Mat'l On Hand	Mat'l Not On Hand	Estimated Cost of Repairs		Actual Cost of Repairs	
	Rep's	New	Rep's	New				Labor	Material	Labor	Material
BOILER AND PARTS:-											
Boiler											
First Ring											
Second Ring											
Third Ring											
Side Sheet Right, Outside											
Flues											
Combination Tubes											
Brick Arch											
Brick Arch Tubes											
Misc:-											
Total											

General Foreman:-

I estimate it will cost $________to perform the above work. I can complete this work in______days.

____
FOREMAN

Form 4a Is Made to Include All Details of Repairs to Boilers and Parts and Is Typical of Forms 4b, c, d, e, and f, Covering the Other Shop Departments.

Forms 4 provide the information called for on Form 5 which is forwarded to the shop superintendent or master mechanic, who in turn forwards it to the superintendent of motive power. Forms 4 are given by the general foreman to the production clerk.

Duties of the Production Clerk

A first-class production clerk saves his salary many times over each year by keeping the stock of finished parts at a minimum. He must not have an excess of any materials on hand; he cannot guess at his stock; he must *know* and his only method of knowing is through the medium of records. The production clerk in the industrial field is not a man of the trades; he is a clerk and must be a brainy one at that.

Again drawing a comparison between the industrial and railroad fields: the superintendent of motive power is the customer who orders engine number so-and-so in for repairs. Figuratively speaking, he pays for these repairs as his success is measured by his cost of maintenance per locomotive mile.

Second, the shop superintendent or master mechanic is the manufacturer and he is in the same position as an industrial manager. If the price, delivery and quality of work turned out by a manufacturer is not up to requirements, the purchasing agent will not give this manufacturer another order, but will let out the business to a competitor. If the cost, quality and speed of locomotive repair work done under the direction of a master mechanic or shop superintendent is not up to the expectations of the superintendent of motive power, the business will be switched, not to another concern, but to another man.

Third, there is the gap in the railroad line-up, as illustrated in Fig. 1, where the general foreman is the production clerk. By creating an additional position at a nominal salary, the general foreman can be relieved of a hundred small, annoying details that come up daily in the locomotive repair shop. Instead of worrying over these infinitesimal things, he can concentrate on the big things.

It has been stated before that the engine clerk in the superintendent of motive power's office instituted Form 2 two and one-half months before the locomotive was due to be shopped. It has probably taken ten days or two weeks to collect information required on Forms 4 and 5; therefore two months are left in which to prepare for the repairs.

The first thing to do is to arrange for the necessary material. Form 6, which is self-explanatory, is filled in by the production clerk and forwarded to the storekeeper after being approved by the general foreman.

It is the duty of the storekeeper to check his stock immediately and if he finds certain items missing, to order them at once. The production clerk should check up with the storekeeper from time to time to see if the material ordered is being received.

Developing a Shop Schedule

By way of illustrating the preparation of a shop schedule it will be assumed that engine 2001 is to be held for general repairs on May 2, and placed on pit 5. A review of Forms 4a, b, c, d, e, and f reflects that the following repairs will be necessary:

Put in new crown sheet.
Patch front flue sheet.
125 new flues.
General repairs to machinery.
Renew one main driving wheel (cracked).
Repair front section frame, right side.
Renew branch pipe.
Renew jacket in cab.
Apply two pair wheels, back tender truck, etc.

The general foreman should call the production clerk and his shop foremen in conference and set up chronologically the repair program for the locomotive. The general foreman has promised on Form 5 that it will take 40 working days to complete the repairs, this schedule being based on the detailed Forms 4. Each detail of the work is discussed and a promise given by the respective shop foremen as to dates of completion, the production clerk making notes as to these dates.

Form 5.
————————1920.

Mr.————————————
Shop Supt.—Master Mechanic.

Dear Sir:

Complying with request contained in the attached form number three, I estimate the cost of repairs to locomotive —————, as follows:

	Labor	Material	Total
Machine shop			
Boiler shop			
Blacksmith shop			
Tin shop			
Tender shop			
Cab shop			
Total			

I figure on placing this engine on Pit Number ——— and estimate it will require about ——— days to complete these repairs.

I have forwarded a list of material needed to the Storekeeper.

Yours truly,

————————————
General Foreman.

....

Mr.————————————
Sup't of Motive Power.

Dear Sir:

Please note the above. This for your information.

Yours truly,

————————————
Shop Supt.—Master Mechanic.

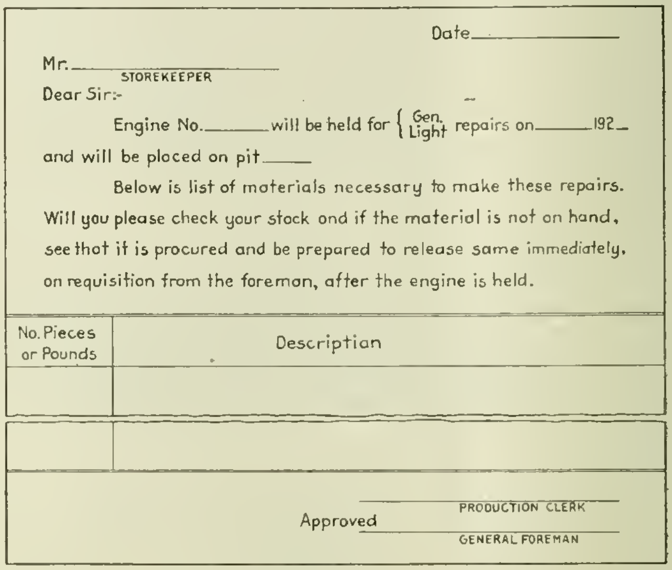
Form 5 Sums up Information on Forms 4 a, b, c, d, e, and f

From the information procured, the production clerk will set up data in a form similar to the following:

May 2—
Engine placed on pit. Tender sent to tank shop.
Stripping gang should start at 1.30 p. m.
May 3—
Stripping gang continues.
Start cutting staybolts for new crown sheet.
Start laying out new crown sheet.
Starts removing old flues and getting new flues made up and cut off.
May 4—
Stripping completed.
Drop driving wheels for removal of broken frame.
Send pair of defective drivers to wheel gang.
May 24—
Boiler shop to complete crown sheet.
May 25—
Frame weld to be completed.
Boiler shop to start applying crown sheet.
May 26—
Repairs to motion work, driving wheels and boxes completed.
June 13—
Shoes and wedges lined.
June 14—
Engine wheeled.
June 15—
Boiler shop work completed.
Valves to be set.
Tender repairs to be completed.
June 16—
Hydrostatic test to be applied and pops set.
June 17—
Tender out of shop ready for coupling up.
Engine out of shop ready for trial trip.

The foregoing gives a brief idea of the schedule which may appear complicated but can be made up in an hour after the first or second trial.

It is the duty of the production clerk to follow up the promises incorporated in his notes, making rounds through the plant twice daily to determine the progress. He should have no authority to criticize the foremen for falling behind but should make notes of any failures to live up to the schedule, reporting this information to the general foreman who will take the matter up with the foremen. The big idea is to get promises from the foremen who will usually do their level best to live up to them. A true sense of co-operation between the general foreman and the production clerk will be of inestimable value to the general foreman and to the operation of the plan.



Date————————

Mr.————————
STOREKEEPER

Dear Sir:-

Engine No.———— will be held for { Gen. / Light } repairs on———— 192—

and will be placed on pit————

Below is list of materials necessary to make these repairs. Will you please check your stock and if the material is not on hand, see that it is procured and be prepared to release same immediately, on requisition from the foreman, after the engine is held.

No. Pieces or Pounds	Description

————————
PRODUCTION CLERK

Approved————————
GENERAL FOREMAN

Form 6 Indicates to the Storekeeper What Materials Will Be Required for Repairs

Upon completion of repairs, Form 3 is made out by the production clerk. The information he has procured from Forms 4 and his chronological schedule will enable him to fill out this form with a few additional questions put to the foremen.

Value of Form 3 for Future Reference

Form 3 is an historical record of what actually happened while the engine was under repairs. It shows the parts repaired and renewed. It also shows special information on some details such as, diameter of wheels and size of journal on engine truck, kind of crank pins, location and make, etc. Should any of these special parts fail, it is merely necessary to refer to Form 3 to see when and where applied, kind of material, size, etc.

On the back of Form 3 is a summary of the cost of repairs set opposite the estimated cost which is reflected in the beginning by Form 5. There is also a space to explain the cause of over-running the estimate. The probable explanation will be some additional work discovered after the engine was stripped that could not be discerned at the time Forms 4 originated. On the other hand, it is possible that the foremen underestimated or that the job took too long.

Injecting the cost features in this system has considerable moral effect on the entire organization. It literally puts them on their toes as they know that their expenditures are being watched. The production clerk procures the cost data from the shop accounting department which already keeps individual costs on locomotives so this will entail no additional work. Form 3 should be made in triplicate; one copy to be retained by the production clerk and two to be forwarded to the superintendent of motive power.

An Appeal for the Shop Schedule

The foregoing incorporates the fundamentals of a shop schedule system, which will assist throughout the entire department. Don't let the bugaboo "diversity of work" deter you from endeavoring to institute some of the big ideas that have placed manufacturing companies years ahead of railroads in efficiency. Don't throttle your general foreman by making him follow up the short ends in his department. Give him a production clerk to dispatch his work and keep the main line open. Don't wait until the management on your railroad decides to install some high class efficiency system which often proves too cumbersome. Beat them to it by developing a simple shop schedule in charge of a live schedule man or production clerk. See that every one co-operates and watch results.

Welding Locomotive Cylinders

BY C. E. FARLEY

General Locomotive Foreman, Horton Shops, Chicago, Rock Island & Pacific

It is a well-known fact that badly broken cylinders are being welded in many railroad shops throughout the country at the present time with gratifying success. Figs. 1 and 2 show the repair of an unusual break in the right cylinder on a Mikado type locomotive. The entire front end of this cylinder was gone, including the division between the steam chest and cylinder. The cylinder had been patched previously, but when a piston head flew off, carrying with it the front cylinder flange, these patches were damaged. Their removal was also necessary in order to get at the broken parts conveniently for welding.

The entire casting was prepared and welded to the cylinder wall all in one piece (previously built up in the welding shop) except the outer wall of the steam chest, which was left open to allow the welding of the dividing wall between the exhaust and admission ports. The usual method of preheating was used, building a brick furnace enclosing the entire cylinder, using charcoal for preheating. The fire was started at 12 o'clock midnight, and the welding started at 7.30 A. M. Using two torches when possible, 16 blowpipe hours were required to complete the job.

The cylinder, welded and ready for the boring bar, is shown in Fig. 2. It will be noted that only one bushing was removed from the valve chamber, the cylinder bushing and the back chamber bushing being left in place. The valve chamber was bored in the front end for reapplying the bushing, the front joints on both valve chamber and cylinder being faced. It was not necessary even to bore the cylinder. All that was required on the by-pass valve chamber was to ream the seat as it lined up perfectly with the back end chamber.

A great deal was saved by not having to remove the bushing, as is the general practice where a heavy job of welding is to be performed. The operation, as described, has been proved practicable by a number of other cylinders that were welded without removing the bushing and are giving good service. The total cost of the welding was approximately $300 for labor and material, making a saving of not less than $700 on the entire job.

The opposite cylinder on this same engine was welded, as shown in Fig. 3, the flange that holds the cylinder to the frame being entirely broken off. The cylinder was removed, turned up at an angle of 90 deg., and the flange welded in place, as illustrated. It will be observed that the cylinder is supported by a chain, and the broken flange, which rests on top, must be welded at the back and the four bridges. The cylinder was reapplied to the engine, all splice bolts being saved and used over again, thus making the cost of this job very reasonable. In all, the two jobs of cylinder welding on this engine cost less than one cylinder in the rough. The welding operations were performed by a local machinist welder, assisted by representatives of the Oxweld Railroad Service Company.

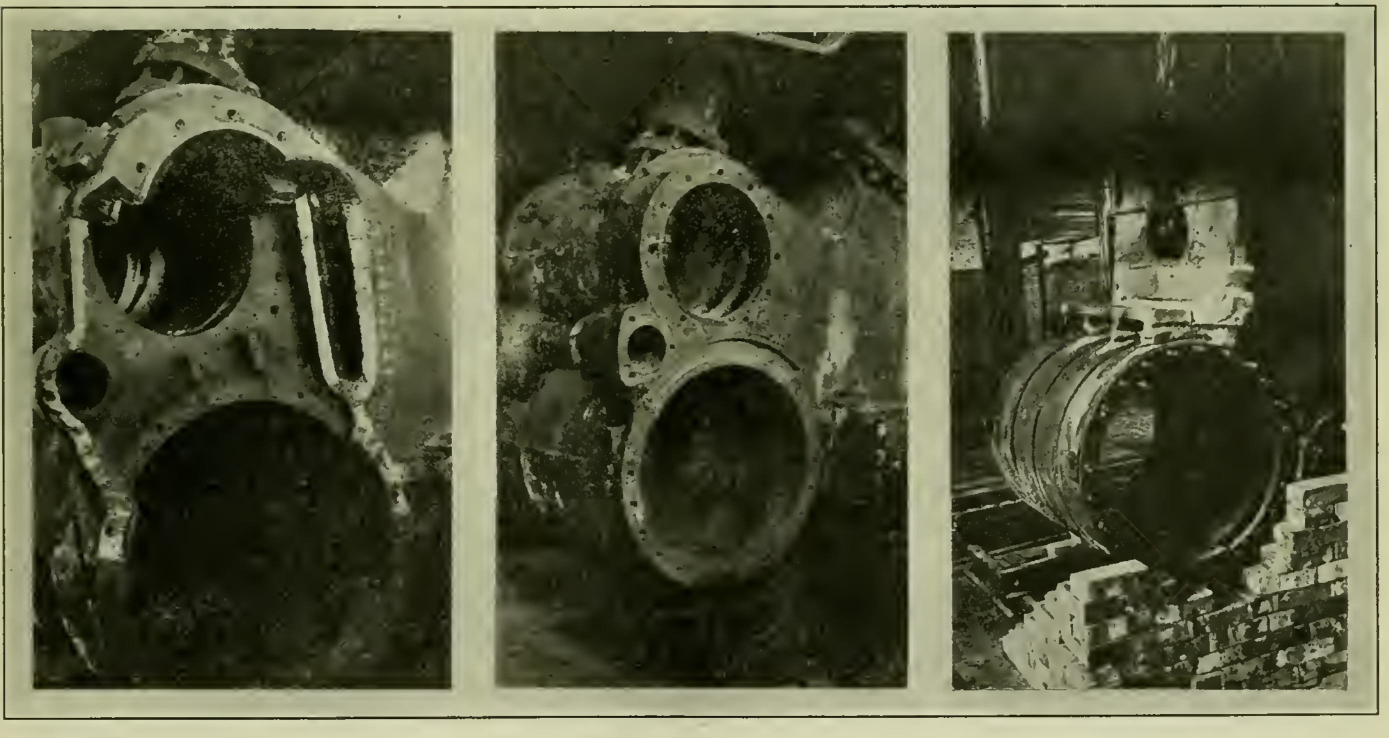


Fig. 1 Fig. 2 Fig. 3

Examples of Difficult Locomotive Cylinder Welding

Application of Shoe and Wedge Liners to Driving Boxes

On almost no question regarding the proper maintenance of locomotives has there been a wider diversity of opinion than regarding the best method of compensating for wear in the driving box shoe and wedgeways. Liners have been applied and held in place by short countersunk head brass screws. In some cases brass liners have been cast in place being held by means of diagonal undercut grooves. Under the severe hammering which driving boxes receive in service, however, liners applied by these methods tend to work loose and require frequent renewal.

To overcome this difficulty, many railroads have adopted the practice of tack-welding steel shoe and wedge liners in place and have thereby greatly reduced the number of liners working loose. Even in applying plates by welding, a considerable divergence of practice has been found, but the method illustrated has shown good results.

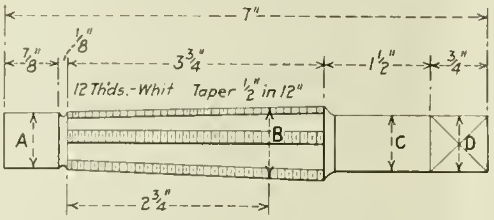
Driving Box Shoe and Wedge Liner Tack-Welded in Place

These shoe and wedge liners are made of steel and beveled on the edges by planing, a number of liners being held at the proper angle in a planer chuck and planed at the same time. The liners are welded to the driving box shoe and wedge ways at the edges and, to assist in holding the liners, six holes are punched in them for tack welding as shown.

Tapping Radial Holes in Boiler Shells

The difficulty which inexperienced workmen find in tapping holes in boiler shells so that studs applied in these holes will be on radial lines, is well known. For example, most air compressor brackets are supported on the barrel of the boiler by means of six studs. The brackets range from 2 to 3 ft. long and the studs are about that distance apart. If tapped into the boiler on radial lines the studs will not be parallel, but many times an attempt is made to have them parallel and the result is undue strain on the stud to say nothing of an unworkmanlike looking job.

In order to overcome this condition and facilitate the application of boiler studs along radial lines, the tap illustrated has been devised. The end of the tap is extended as shown at *A* in a cylindrical surface equal in diameter to the smallest diameter of the thread. With care in drilling the boiler shell on a radial line (the diameter of the hole being slightly larger than *A*) the tap will obviously start in the direction of the drilled hole and, as a result, the hole will be tapped along a radial line. The proportions of *A*, *B*, *C*, and *D* are shown in the table for seven different sizes of taps. The use of this tap will also aid in tapping a hole at right angles to a given plain surface, following the direction of the drilled hole as previously described.



D	C	B	A
1/2"	5/8"	5/8"	1/2"
9/16"	3/4"	3/4"	5/8"
5/8"	7/8"	7/8"	3/4"
11/16"	1"	1"	7/8"
3/4"	1 1/8"	1 1/8"	1"
3/4"	1 1/4"	1 1/4"	1 1/8"
13/16"	1 3/8"	1 3/8"	1 1/4"

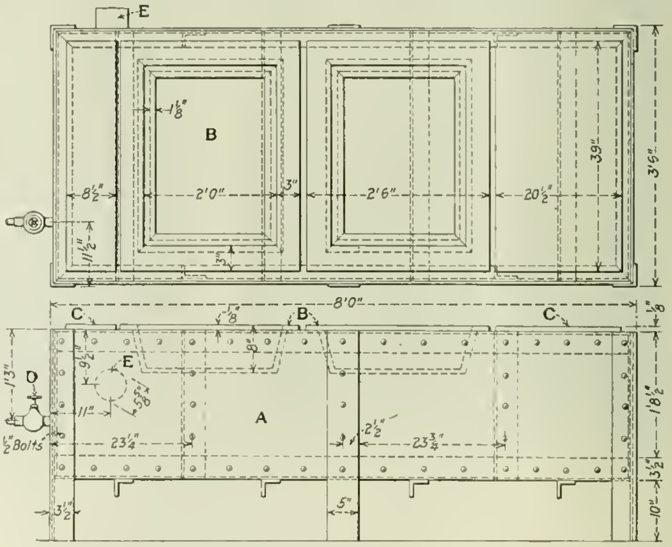
Tap Developed for Tapping Radial Holes

An Easily Made Babbitting Furnace

BY E. A. MILLER

For babbitting driving boxes, crossheads and other miscellaneous locomotive parts, the babbitting furnace shown has given exceptionally good service. The furnace *A* is supported by four ½ in. by 3½ in. by 3½ angle irons and ½ in. by 5 in. plates centrally located on each side. The furnace is made of 5/16 in. sheet iron, both sides and ends being stiffened all around by 5/16 in. by 3½ in. plates riveted to all the vertical supports. The side sheets and bottom are stiffened by four 5/16 in. by 3 in. angles. There is also a reinforcing angle iron all around the top which supports two cast iron babbitt containing pans *B* and two cast iron plates *C*.

The bottom and sides of the furnace are lined with 3 in. fire bricks covered with fire clay. A burner *D* for crude oil is provided; also a vent *E*. The cast iron pans are 1⅛ in. thick and 6⅞ in. deep inside. Removing one or both of the cast iron plates *C* will tend to cool off the furnace as desired, and they can also be used to preheat certain parts, such as rod brasses, etc. This furnace has given satisfactory service and a number similar in construction are now in use.



Babbitting Furnace of Simple Design

Making a Drill Live Up to Its Reputation

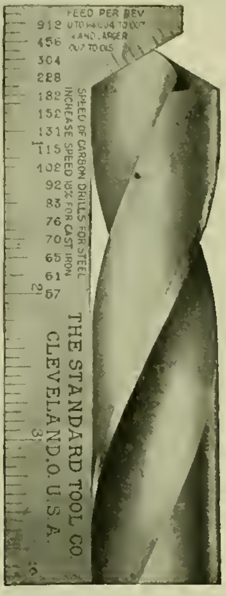
Satisfactory Results in the Use of Twist Drills Can Be Secured in One Way Only—by Correct Grinding

BY H. WILLS
The Standard Tool Company, Cleveland, Ohio

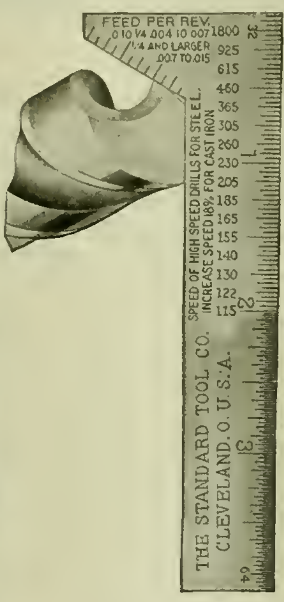
WHEN considering the almost human mechanical appliances employed in making standard types of twist drills and the precautions taken in the various operations from the laboratory tests of the steel bars to the final inspection, it is a fairly safe conjecture that if a drill gives trouble, some of the conditions surrounding its use are not right.

Twist drills will stand more strain in proportion to their size than almost any other tool and a large percentage of drill troubles could be eliminated with proper attention given to grinding the points. The form of the drill point controls the rate of production, accuracy of the hole, frequency of necessary grinding and the life of the drill. In fact, the most carefully made drill can be spoiled by poor grinding.

In testing a drill to determine whether or not it is properly ground, the first requirement is some form of twist drill grinding gage chart and scale, as illustrated. Two methods of holding the scale while measuring the length and angle of the cutting lip, also when estimating the approximate center angle, are shown. Although the included angle of the gage is only 118 deg., a close estimate on the recommended center angle of 130 deg. can be made.



Measuring Length and Angle of Cutting Lip



Estimating Approximate Center Angle

Twist drills must be properly ground and run at the correct speeds and feeds in order to do their work efficiently and with the aid of the gage illustrated, any skilled workmen can obtain these best results in increased drilling production. The gage is ground to an angle of 118 deg. and is graduated in thirty-seconds and sixty-fourths on one side and sixteenths on the other. The gage indicates the proper angle and length of lip to which the drills should be ground. It also shows the speeds and feeds recommended for drilling steel and cast iron, one side when carbon steel drills are used and the other when high speed drills are used. Opposite each 1/8-in. mark is a number showing the proper speed at which to run a drill of corresponding diameter.

Correct and Incorrect Grinding

Both cutting lips must be inclined at the same angle with the axis of the drill and must be of equal length. The point angle of 59 deg. (Fig. 1) has been universally adopted as best suited for average conditions. The drill point must have the proper clearance or contour of surface back of the cutting edges and this clearance must be identical on both sides. Approximately a 12 deg. clearance angle (Fig. 2), combined with the center angle of 130 deg. which will give a constantly increasing clearance toward the center, has proved best for average conditions.

Some of the undesirable conditions resulting from drill points improperly ground are illustrated. If both lips are not ground at the same angle with the axis (Fig. 3), one lip will fail to counteract the tendency of the other to spring away from the cut; consequently, one lip will do more work than the other, which will result in its becoming dull more rapidly than if both lips were cutting equally. In addition, it will be subjected to an abnormal torsional strain.

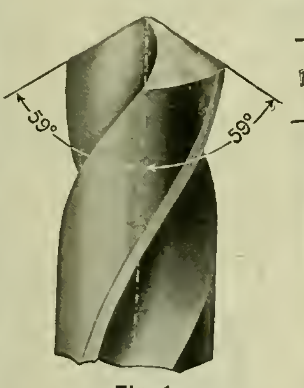


Fig. 1

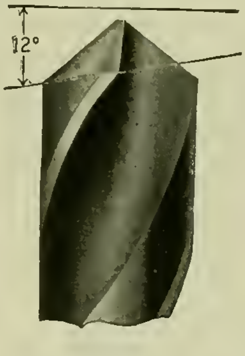


Fig. 2

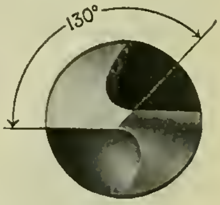


Fig. 2a

When the cutting lips of a drill have the same point angle, but are of different lengths (Fig. 4), the point of the drill will be "off center" or eccentric. As a result, the hole will be oversized to an extent equal to double the amount of this eccentricity. If the drill point is ground with both lips at different angles and of different lengths (Fig. 6), there will be a combination of the undesirable results described in the last two paragraphs.

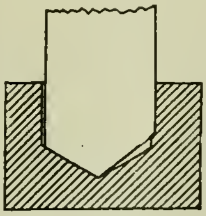


Fig. 3

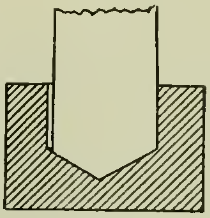


Fig. 4

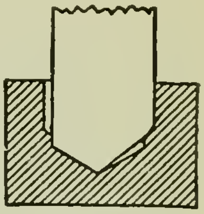


Fig. 5

The side and end views of a drill with the proper point angle (59 deg.) and the proper angle of clearance at the periphery (12 deg.), but with insufficient clearance at the point or center, are shown in Fig. 6.

A drill with insufficient clearance both at the periphery and at the center is illustrated in Fig. 8. The line *ABC* is at an angle of 12 deg., but there is no clearance immediately back of the cutting edges *BC* and the excess of clearance at the heel *AB* is of no benefit. The common result of grinding a drill with insufficient clearance is plainly shown in Fig. 8, and this splitting is almost sure to follow any attempt to obtain maximum production.

A drill with the proper clearance angle of 12 deg. is shown in Fig. 9, but it does not have the proper contour back of the cutting edges. This manner of grinding leaves the cutting edges thin and weak, causing them to crumble away under heavy speeds.

Maintaining Standard Web Thickness

Most twist drills are made with a gradual increase in the thickness of the web or center of the drill toward the shank. As the drill becomes shorter and the web thicker, greater force is required to drive it. To overcome this condition, it is good practice to thin the web to the original dimensions. This grinding must not extend too far up the flute of the drill and care must be exercised that the cutting lips are not injured; also that the same amount is ground out of each groove. Fig. 10 shows a drill with the web properly thinned. In Fig. 11, the grinding is excessive, leaving the web entirely too thin and liable to crumble. When this happens, a split drill is practically inevitable.

Incorrect grinding is usually the cause of drills splitting up the center, and no manufacturer should be called upon to replace a split drill, unless a flaw is evident in the steel.

General Precautions to Observe

Twist drills are made with a slight taper from point to shank, so that the largest diameter is always across the corners of the cutting lips. This prevents the drills from binding in the work, when they are sharp. If the outer corners are allowed to become badly worn, the drills will bind and cannot perform satisfactorily. Whenever the outer corners of the cutting lips show wear, the drills should be re-ground and every particle of worn surface removed, or the drills will continue to bind and very quickly be damaged beyond repair.

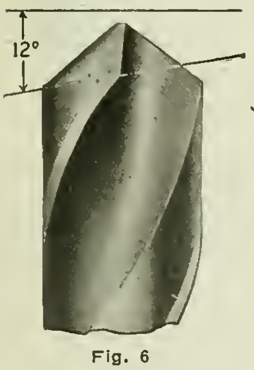


Fig. 6

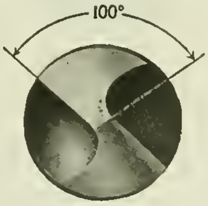


Fig. 6a

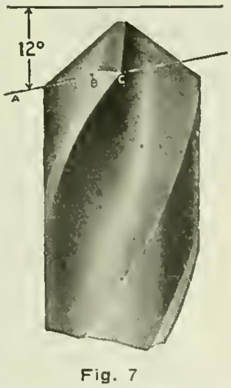


Fig. 7

In grinding high speed drills, care should be taken not to overheat them, and when heated they should never be plunged into cold water. Doing so is likely to cause small surface cracks which reduce the efficiency of the drill and may result in serious damage to it. Forcing the grinding on a wet grinder may also bring about the same condition.

If the suggestions for grinding drill points contained herein are followed and drills are run at the proper speeds and feeds, satisfactory results are practically assured. It is, however, hardly possible to do this grinding as accurately by hand as by using a good twist drill grinding machine, of which there are several on the market, and their use is earnestly recommended.

Broken or damaged tangs of drills are generally the result of an imperfect fit of the drill shank in its socket, which may be caused by a worn-out socket, dirt or chips accumulating in the socket, or bruises on the shank of the drill. In either case the driving power of the taper is reduced or destroyed, resulting in an abnormal strain being put upon the tang.

A drill of either carbon or high speed steel that can be filed is not necessarily too soft for service; in fact, if drills were tempered so that a good file would make no impression, they would be entirely too hard for general use. Any doubt regarding the temper can be checked by trying the drills in actual service.

Fig. 8

Fig. 9

Fig. 10

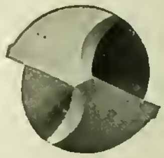


Fig. 11

Speeds and Feeds

There are so many conditions affecting drilling operations that it is extremely difficult to establish hard and fast rules for speeds and feeds. Published tables can be safely followed when drilling in commercial materials and experience will enable the operator to determine what changes, if any, can be made from them. Assuming that a drill is properly ground, when the corners of the cutting lips wear away rapidly, it is an indication that the speed is too great. If the cutting edges roughen or break out in minute particles it indicates that the feed is too great. A word of caution will not be amiss regarding the use of very small drills. It is seldom that these are run at more than a fraction of the speed necessary to obtain the best results, and excessive breakage is inevitable. These small drills are delicate tools; be sure they run true and that the cutting edges are kept sharp. A fine grade emery stone is best suited for this purpose.

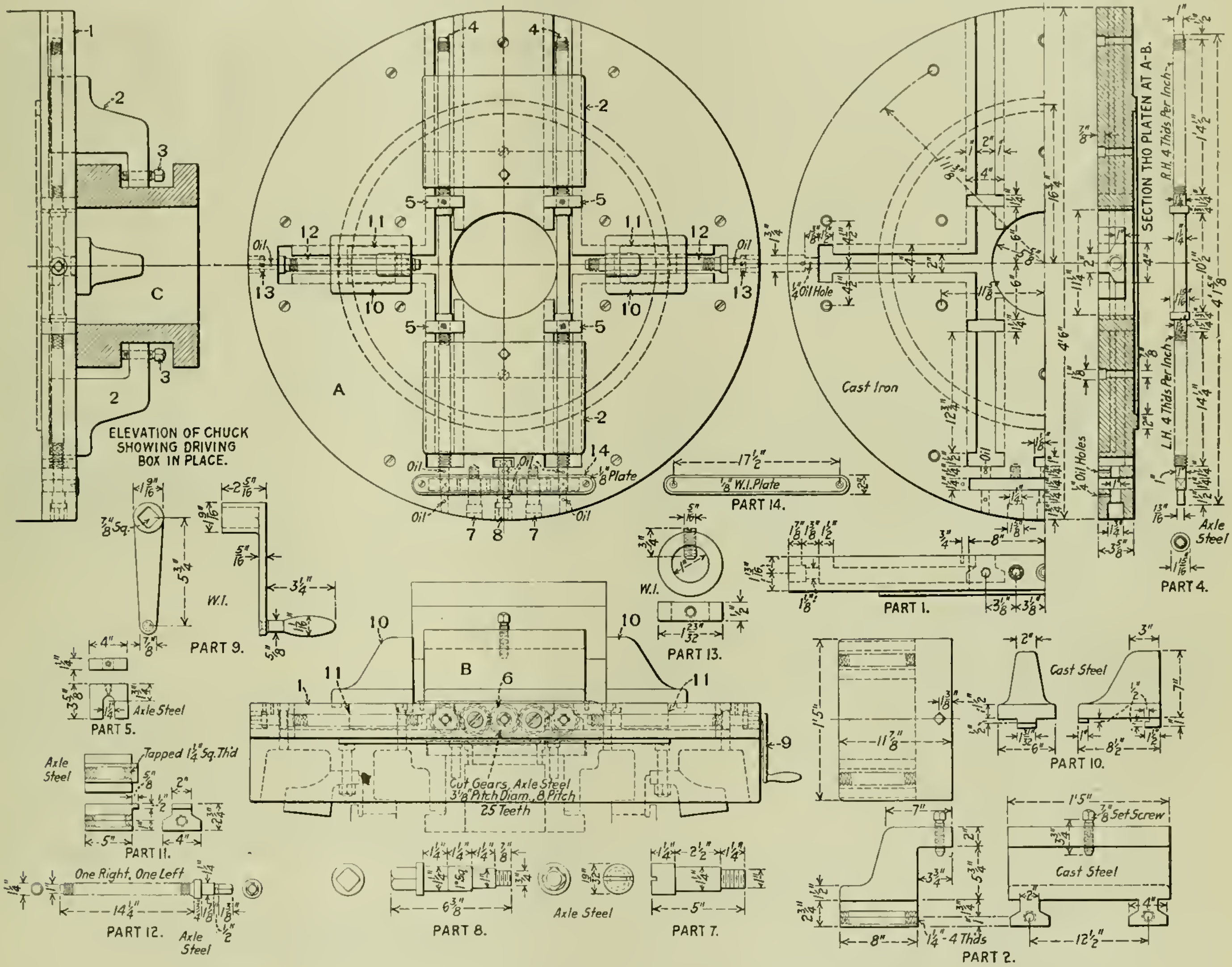
Driving Box Chuck

BY E. A. MILLER

A driving box has been developed, as shown in the illustration, for application to 54 in. boring mills, and its use will result in a considerable saving in the time ordinarily required to set up driving boxes preliminary to the operation of boring crown brasses. Referring to the illustration, *A*, *B* and *C* are the plan, front and side elevations of the assembled driving box chuck. Details of the individual chuck parts also are shown, and will aid in a full understanding of the operation of the chuck.

The base plate *1* is made of cast iron 3⅝ in. thick and provided on the under side with a ring which fits in a corresponding groove in the boring mill table. The chuck is secured to the table by means of fifteen ⅞-in. bolts, with round, slotted heads flush with the top surface. The base of the plate *1* is slotted, as shown in the detailed view, to receive the working parts of the chuck. Two large jaws *2*, which are provided to center the driving box, work together, one being drilled and tapped with four right-hand square threads per inch, the other jaw being tapped with four left-hand square threads per inch. Two long screws *4*, provided with right and left-hand threads are arranged to screw into the movable jaw *2*. Any rotation of the screws, therefore, causes the jaws to move together or apart depending upon the direction of rotation.

Care must be taken in assembling to see that the long screws are started in the jaws at the same time so the jaws will centralize. Four axle steel pieces *5* are arranged to fit corresponding slots in the base and by contact with shoulders on the long screws as shown, prevent longitudinal movement of the screws. Five eight-pitch gears with 25 teeth each are arranged in a train as shown. The middle and outside gears are provided with square holes for application to the long screws and the operating pin *8*; the other two gears are idlers mounted on pins *7*. Pins *7* are provided with 1 in. threads on the ends and make into corresponding tapped holes in the platen. Pin *8* is held in place by a ¾ in. nut on the end and a cotter to prevent it from working off. It is evident that, through the train of gears, the turning of pin *8* by means of handle *9* will turn the long screws in the same direction and move the jaws *2* together or apart as may be desired. Movement of the jaws is simultaneous.



Driving Box Chuck as Applied to 54-In. Boring Mill

The small jaws *10*, like the larger ones, are of cast steel but are not tapped out for the 1¼ in. square threads (four threads per inch). Two additional parts *11* are arranged to fit grooves in the platen and threaded to receive the 1¼ in. short screws *12*. The detailed views of parts *10* and *11* will indicate how they fit together and how turning one of the short screws will cause movement of the small jaw in or out, depending upon the direction of rotation. The two parts *11* are tapped, one with a right, and the other with a left-hand thread. These parts and the short screws have to be assembled before the long screws and main jaws are put in place. Two collars *13* are provided for application to the short screws after they are in place and prevent their longitudinal movement. A set screw in each collar provides for its adjustment on the short screw and for tightening in the desired position. A gear guard *14* is provided to cover the five gears and keep them free from chips. The 11¼ in. hole in the center of the platen allows all chips to drop through and prevents interference with the boring bar. Oil holes are provided throughout to lubricate moving parts. As an additional precaution to insure accurate work, two set screws *3* are provided in the large jaws *2*. Tightening these set screws after the centering jaws have closed against the driving box, will hold the box firmly to the platen and prevent any tendency to tip up on one side. For the rapid, accurate machining of driving boxes this chuck has demonstrated its value.

Curing Troublesome Frame Failures

BY FRANK ROBERTS

In going over the records for the past four years, it was found that 205 broken frames had been welded at the principal repair shop of a road having about 350 locomotives. Attention was especially attracted to the number of failures at the foot of the pedestals, shown at *A*, Fig. 1. By actual count there were 86 cases where the break was at one pedestal; seven cases where two pedestals were broken on the same locomotive and one case where three were broken on one locomotive. Altogether 103 pedestals were welded. All the rest of the frames broken in various places totaled 102. It has been found that 50 per cent of our frame failures occur at the pedestal foot.

This proves conclusively that the design of this part of the frame should be changed and it is a simple matter to increase the section sufficiently to insure against such failures. Fig. 1 shows the location of typical failures. There is usually so little difference between dimension *B* and the depth of the binder slot that the binder comes up very close to the frame, making it necessary to cut a fairly sharp corner at *C*. A sharp corner is always a weak point and dimension *B* should be made ½ in. or ¾ in. longer to leave a good protecting fillet at *C*.

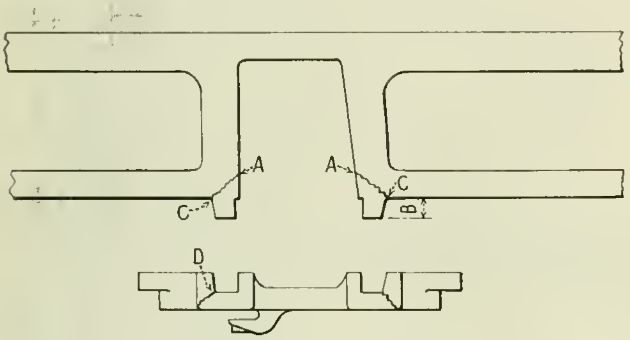


Fig. 1—Sketch Showing Location of Frame and Binder Failures

As a measure of increased strength the foot should be carried back along the frame about two inches further as shown in Fig. 2. This alteration will strengthen the pedestal foot and eliminate breaking at this point. Any man familiar with shop or enginehouse troubles is fully aware of the extent and expense of the above failures and the engineering department will at once appreciate the reasons for making the change as well as the effectiveness of the proposed change in design.

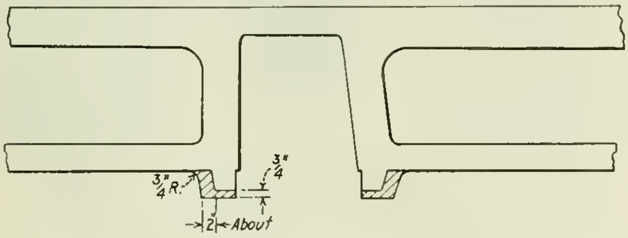


Fig. 2—Proposed Method of Strengthening Pedestal Foot

Considerable trouble has been experienced also through the failure of pedestal binders. The breakage occurred at point *D* in Fig. 1 and the design of the binder was changed, making a ¼-in. fillet at the bottom of the opening, thereby stopping the trouble. The whole fit of the binder on the pedestal had to be redesigned for the new pedestal, making arrangement for a good fit with no bearing on the fillets.

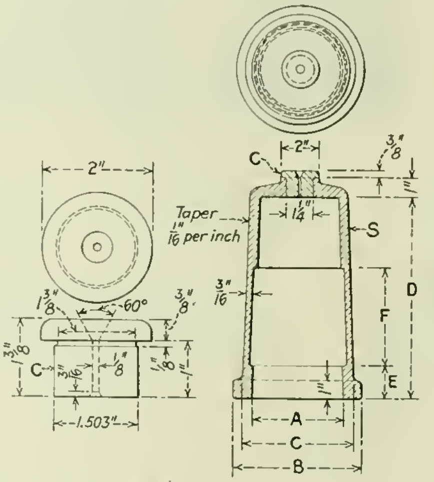
It is desirable to so design locomotive frames that the weakest link will be the part that can be most easily repaired. Certainly the pedestal foot is a hard part to repair and if breakage must take place, it is much better to have it in the binder than in the frame. The present improvement in strengthening the frame should place the advantage on the side of the frame.

Piston Rod Centering Sleeve

BY E. A. MILLER

If often happens that the end of a piston rod becomes battered in disconnecting the crosshead and in some cases the center is so badly damaged that it is exceedingly difficult to true the piston rod in the lathe or grinding machine. To overcome this difficulty, a special centering sleeve has been devised as shown in the illustration.

The sleeve *S* is made of axle steel, being reamed to the standard gage for the tapered piston rod end. Dimensions are shown for six different sizes of centering sleeves, arranged to fit practically all classes of piston rods received for repairs. It will be noted that the inside taper fit of the sleeve is relieved for at least half of the fit and this allows easy application or removal of the sleeve without impairing its accuracy. The outside of the sleeve *S* is tapered 1/16 in. per inch. A tool center *C* is made to the shape and dimensions shown, being hardened all over and ground, with an allowance of .003 in. for the shrink fit in the sleeve.



A	B	C	D	E	F
5 13/16"	6 15/16"	6"	11"	1 3/4"	5 3/8"
4 5/8"	6 3/8"	5 3/8"	10"	1 5/8"	4 7/8"
4 1/2"	6 1/4"	5 1/4"	10"	1 1/2"	4 3/4"
3 9/16"	5 5/16"	4 5/16"	8 1/4"	7/8"	4 1/2"
3 59/64"	5 43/64"	4 11/16"	8 3/4"	1 1/8"	4 3/8"
5"	6 3/4"	5 3/4"	11"	1 3/4"	4 7/8"

Centering Sleeve for Piston Rods with Damaged Centers

The application of this centering sleeve gives the same results as the original center in the piston rod, and will be found to save a large amount of time in truing up piston rods with damaged centers.

Hardening Hammer Die Blocks*

BY R. B. KERR

Since the introduction of the modern drop forging hammer, the problem of producing and successfully heat treating large dies to get the maximum of service with a minimum of loss, has engaged the attention of steelmakers and steel treaters alike.

Early in the game it was found that the percentage of loss from hardening from various causes was heavy. Flaws or pipes in the interior of the blocks resulting from improper casting or forging; steel of too high or irregular a carbon content; and more especially inadequate tempering room equipment, are among the chief causes of failure. The un-

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*Abstract of a paper presented by title by R. B. Kerr, foreman, heat treating department, John Deere Harvester Works, East Moline, Ill., before the Philadelphia convention of the American Society for Steel Treating.

fortunate hardener too often is made the goat for the sins, mostly of omission, of both the steelmaker and the shop foreman.

Directions for Heating

While die blocks can be heated successfully in either coke or oil furnaces or even in the smith's forge, a gas heated furnace of the oven type is by far the most convenient and satisfactory for this work. Coke makes a nice clear fire of fairly simple regulation, and with a skillful heater in charge, good results can be obtained. An objection to its use is the frequent presence of impurities, particularly sulphur.

When heating dies the considerable air pressure required to burn fuel oil, makes necessary the most extreme care to prevent scaling or surface decarburization in the parts to be treated. The furnace, therefore, should be of the muffle type, the heating chamber completely inclosed, or if this is not available, the die should for protection be packed face down in a gas tight box of suitable size half filled with charcoal, and the whole thing heated up.

It might be said in passing that this method of pack hardening is excellent for heating dies and tools of nearly all descriptions. The parts come out of the packing box uniformly heated with a surface perfectly free from scale and in the best possible condition for hardening. The process is an old and successful way of heating steel and deserves to be more widely known and practiced.

Whatever the type of furnace used or the means employed the all important thing is to get a good heat on the die (a thorough slow soaking, uniform heat) for upon that depends to a great extent the success or failure of the operation. Particularly for the benefit of the younger steel treaters it may be said that thorough careful heating, more especially when handling comparatively large blocks of steel, is most essential.

For heating, a gas-fired, oven furnace of ample capacity should be used as being most convenient and suitable for the job. If the oven is already hot so much the better, if not, it should be brought up pretty well before putting in the work. Dies of any description should not be put into a cold furnace. Nothing is gained in time, and besides some chances of surface decarburization are offered with a too rapid increase in temperature.

Place the die in the furnace face down, unless the nature of the impressions makes this impossible, in which event it is good practice to protect the surface from possible gases by laying a closely fitting piece of asbestos or sheet steel on top while heating. As another precaution, if the die is of considerable size and the impressions are deep or irregular, it is well to bring it up to a dull red heat, about 1300 deg. F., and let it partly cool off in the furnace before taking the hardening heat.

Heat slowly and regularly. The time required will vary in proportion to the heating area of the furnace and the size and shape of the piece to be treated. Usually three to five hours are required for drop forging dies of average size. The most important point is to get a uniform heat throughout the piece, and one of the most valuable assets a steel treater can have is the ability to judge or sense correctly when a large block of steel is heated properly throughout. The average grade of hammer die steel will harden nicely at around 1450 deg. F. and the heat always should be held stationary for at least 15 minutes before removing the die from the fire. This insures a uniform temperature throughout the entire die.

Quenching and Drawing

The quenching tank should be of ample size and the water supply arranged so that it can be forced upward against the face of the die with considerable force and volume, using an overflow pipe of sufficient size to take it away. In most cases clean fresh water is all that is necessary, but if extreme hardness is required or if the water is soft or muddy, the addition of a little salt will sharpen it. Place a resting rack across the top of the tank, arranged at a sufficient depth so that the impressions on the face of the die will be well covered with water when the die is laid on it. On flat surfaced dies or on dies in which the impressions are shallow, a depth of from 1 to 1½ in. is about right.

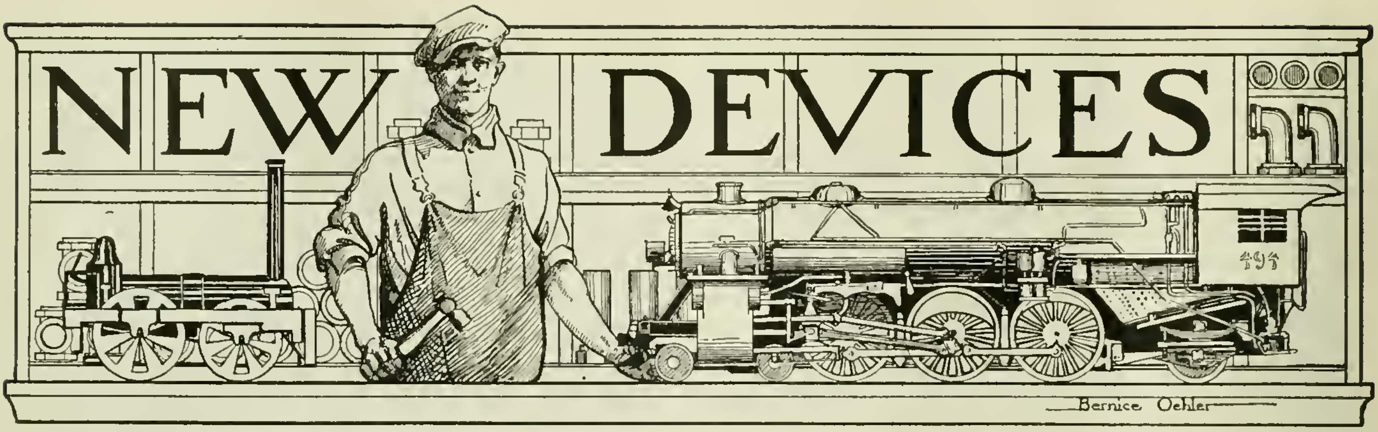
When all is ready get the piece out of the fire. If there are any dangerous looking corners or sharp projections that do not need to be hard, partly cool them off with a water jet or piece of water soaked waste to prevent chipping. Place the die on the resting rack face down and turn on the water. If the piece is wide or flat, prevent warping or crowning by keeping the back slightly cooled off; just enough water and no more. Run the hand over the face frequently to find how it is cooling off.

The temper should be drawn slightly on all hammer dies, both to relieve strains and to give them resiliency or spring, as well as for better wearing qualities, and the drawing should be begun immediately, even before the die is quite cooled off. If there is an oil tempering furnace at hand large enough, get the piece into it. Raise the temperature to around 400 deg. F., and hold it there for an hour or so. If for any reason this method cannot be used, swab the die with light machine oil and place it in a furnace partly cooled off. Leave it there until the oil begins to flash, then remove and allow it to cool off in the air.

Danger Due to Internal Friction

A die should never cool off entirely in the water. When a mass of steel at the hardening temperature is plunged into cold water, the grains in its outer surface immediately become set and rigid. A certain amount of contraction and shrinkage also takes place, partly because of the change from high to low temperature, and also because of the hardening of the metal. The amount of this shrinkage is in exact proportion to the surface area of the mass being treated; the greater the area the more the shrinkage. If this change took place all the way through there would be no trouble; but it does not. In the first place the interior of the piece cools off much more slowly than the outside, and, secondly, the setting of the grains, due to hardening, extends in a depth of from only ¼ to ½ in. at the most. This suddenly chilled outer layer is consequently being forced against the softer mass inside with an enormous pressure, causing distortion and strains which become more marked as the piece cools off. When the temperature recedes to a certain stage, governed partly by the temperature of the quenching water and the air, a violent action takes place. This is the danger point. The friction created by the molecules striving to adjust themselves to the new conditions generates heat inside. Heat means expansion, and unless this condition is offset promptly by heat applied to the outside to relieve the strains, the die, particularly if a large one, has about an even chance of bursting open. Whether it does or does not, the strains are there and are just as liable to manifest themselves in service later on with possibly more serious effects than if they appear immediately after hardening.

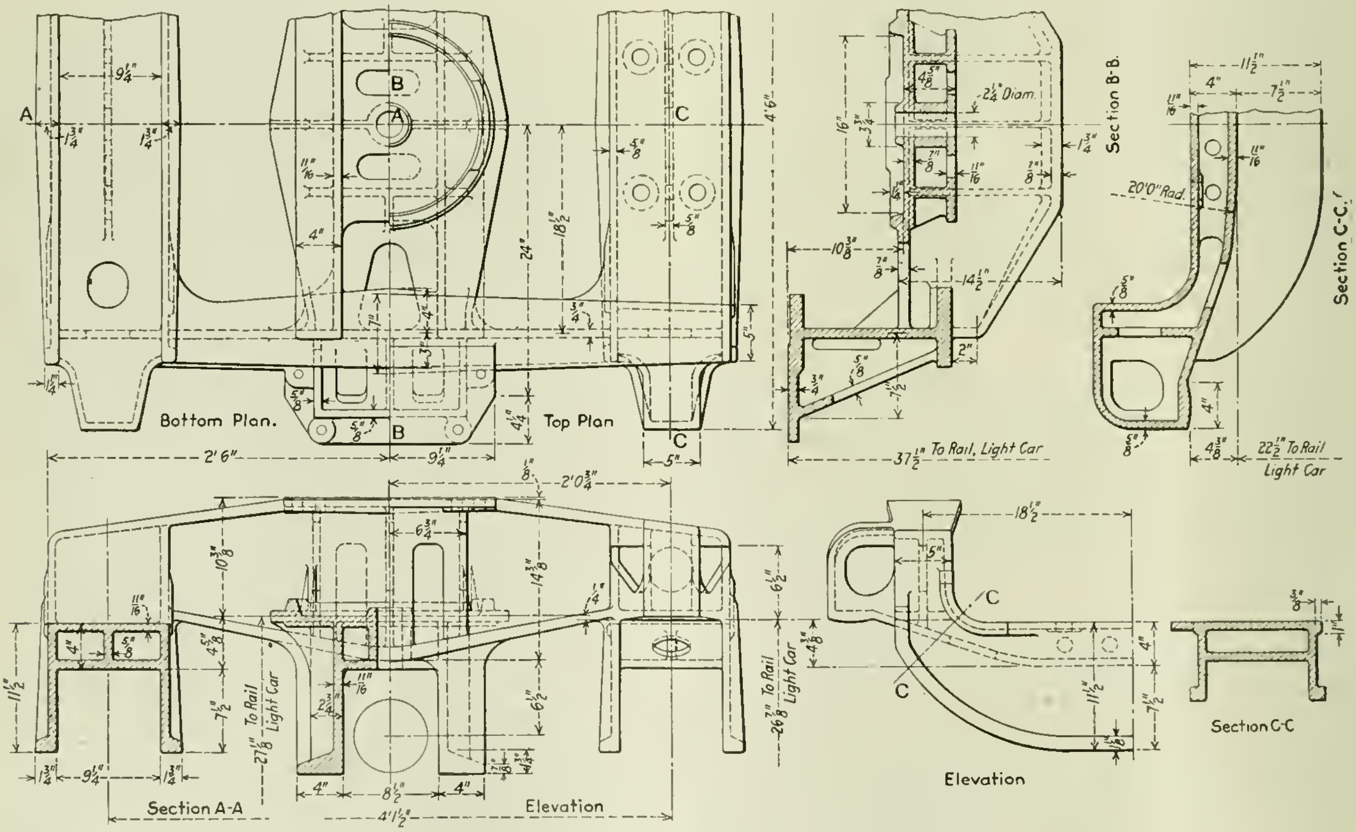
Allowing the dies to remain in the water too long and failure to draw the temper promptly after hardening is responsible for considerable breakage. This is partly due to the lack of proper equipment, and also to the fact that the principles involved are not so generally understood as they might be even among steel hardeners. This heat generation by friction, or as some might call it, molecular reaction inside of a body of steel, is no pet theory, but the author has noted its effects during many years of close observation and practice in the heat treating of steel, and believes it will be found in line with the natural laws governing cooling bodies.



Lamont Six-Wheel Truck for Freight Cars

A NUMBER of designs of equalizing six-wheel trucks have been developed for freight cars varying in capacity from 90 tons to 120 tons. The Lamont truck, the most recently developed of this type, has been brought out by the American Steel Foundries, Chicago, and has received its first installation under several of the new 120-ton coal cars built for the Virginian.

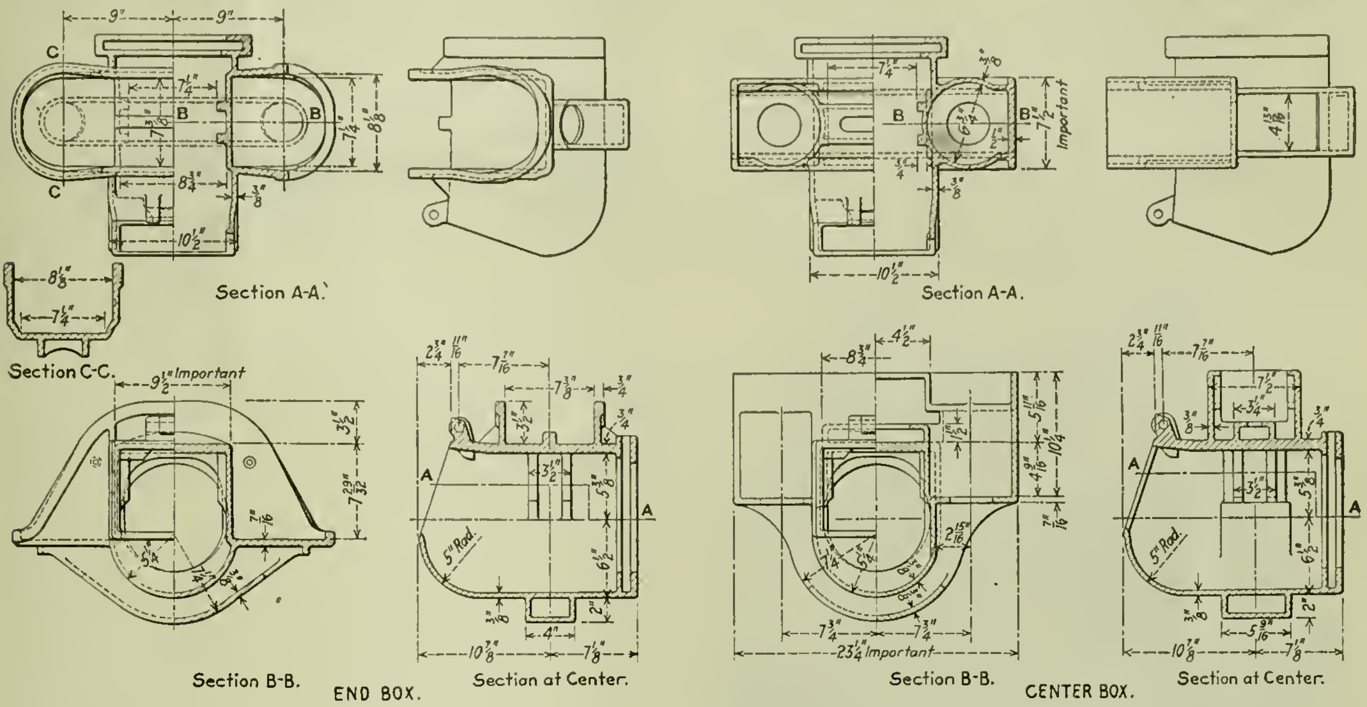
This truck differs from other six-wheel trucks for freight cars in bolster construction, the method of equalizing and the arrangement of the springs. The feature of the bolster design is its three-part construction, which provides for cross equalization of the load distribution to the four points of delivery to the longitudinal equalizing mechanism. The equalizing mechanism permits a symmetrical location of the bolster ends between the wheels, thus making possible a short wheel base and a simple arrangement of the brake rigging.



Details of the Equalizing Bolster

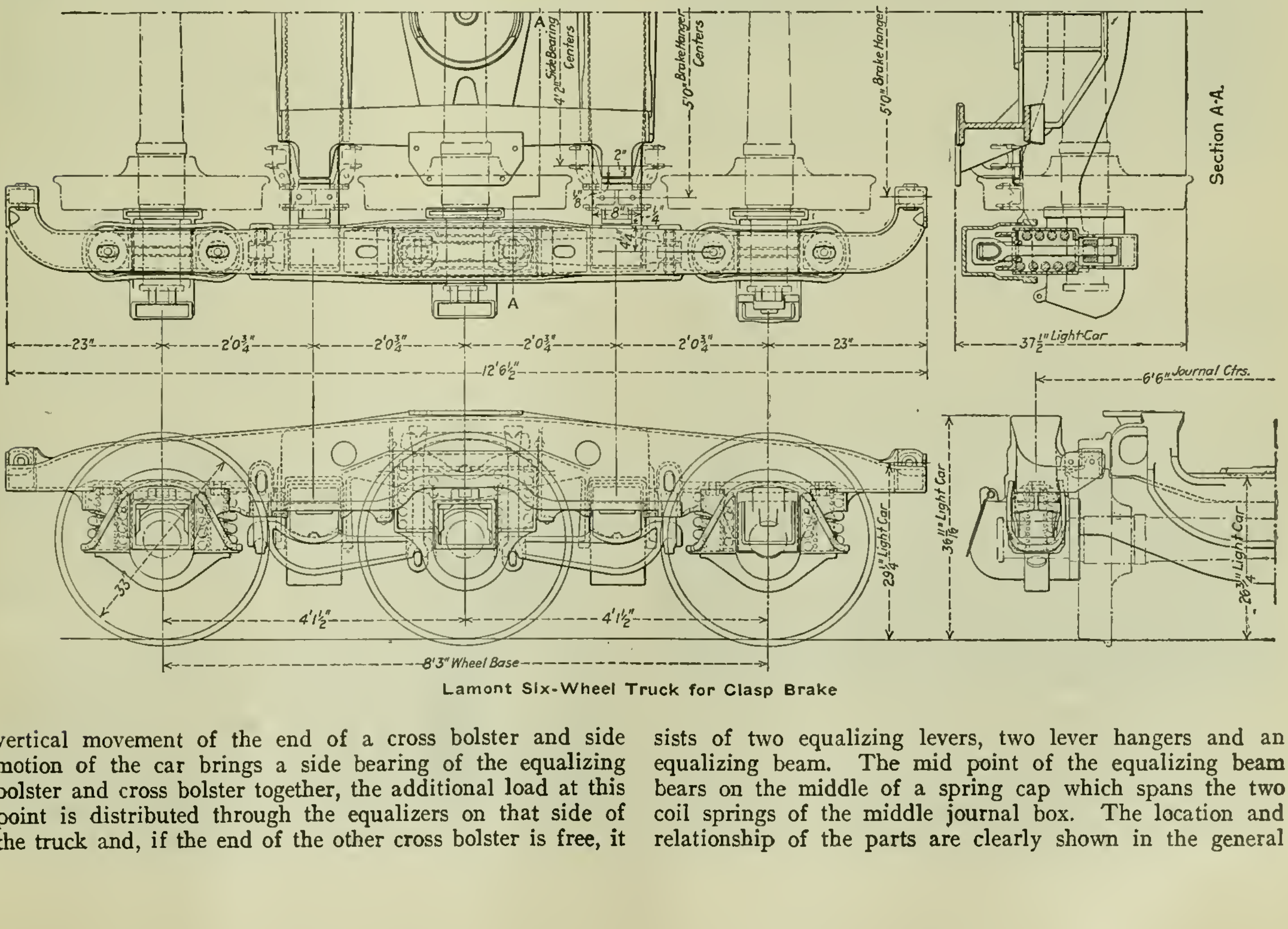
The springs are placed directly over the journal boxes and coil springs are used throughout.

The bolster consists of three parts: two cross bolsters and one equalizing bolster. The ends of the cross bolsters rest on the equalizing levers, and the equalizing bolster, which carries the center plate and truck side bearings, bears at the center of the cross bolsters with a clearance of ¼ in. at the side bearings when the car is riding level. The construction of the equalizing bolster is shown in one of the drawings, from which it will be seen that the center plate load is delivered to the side members of the equalizing bolster and through these to end portions which, taken separately, are inverted U-shaped bolsters designed to bear at the center of the cross bolster and nominally take one-quarter of the center plate load at each end. The bearing surfaces of these end portions of the equalizing bolster are curved to a radius of 20 ft. This permits a rocking movement of the equalizing bolster on the cross bolsters, and also provides for a limited amount of upward or downward movement of the ends of the cross bolsters as the wheels pass over inequalities in the surface of the track.



Details of the Journal Boxes

Under average track conditions this insures an equal distribution of the center plate load over the four points of delivery to the equalizing system. When a combination of vertical movement of the end of a cross bolster and side motion of the car brings a side bearing of the equalizing bolster and cross bolster together, the additional load at this point is distributed through the equalizers on that side of the truck and, if the end of the other cross bolster is free, it may be partially carried back across the truck to the other equalizing system.

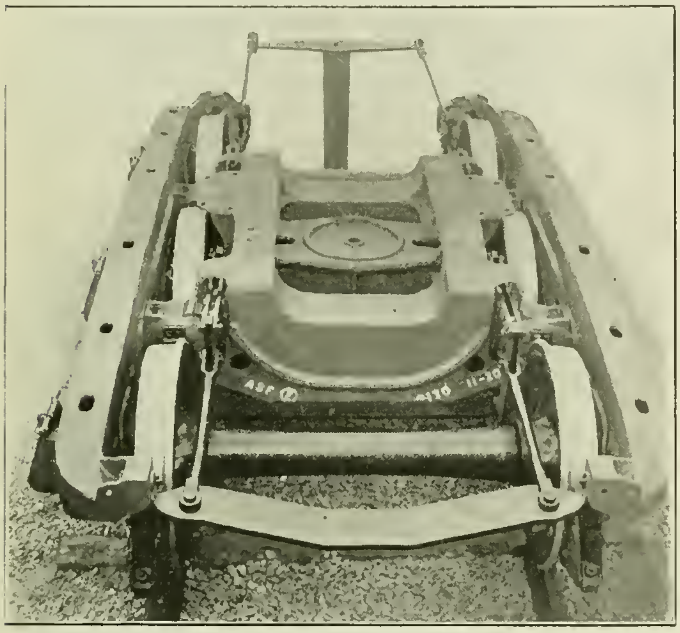


Lamont Six-Wheel Truck for Clasp Brake

Because of the clearance provided between the side bearings of the equalizing bolster and the cross bolster, very little clearance, if any, is necessary between the car body side bearings and the roller side bearings attached to the equalizing bolster.

The equalizing mechanism on each side of the truck consists of two equalizing levers, two lever hangers and an equalizing beam. The mid point of the equalizing beam bears on the middle of a spring cap which spans the two coil springs of the middle journal box. The location and relationship of the parts are clearly shown in the general drawing of the truck. The load delivered to either end of an equalizing bolster is taken up by an equalizing lever and delivered in the ratio of two to one, to the end and middle journals, respectively—to the end journal indirectly through the side frame, springs and journal box and to the middle journal through the lever hanger, equalizing beam, springs and journal box.

The journal boxes are of special design in which pockets have been provided on either side to receive the coil springs. Thus located, the springs support the maximum amount of dead load, they are protected through the equalizing mechanism against overloads and are in the best position to take up shocks from the individual wheels without passing them on to the equalizing system.



A Top View of the Truck, Showing Arrangement of Bolsters and Brake Rigging

Double coil springs are used on the end journal boxes and single coils on the middle journal boxes. The inner coils used on the end journal boxes have a free height 2¼ in. greater than the heavy outside coils. They are compressed to the height of the outer coils under the light weight of the car, and with this compression exert a force on each of the end journals of approximately 1,750 lb. The heavy coils are the same on both the end and middle boxes and are necessarily of high capacity, compressing only about ⅛ in. under the light weight of the car. Because of this comparative lack of resiliency under the weight of the empty car the inner coils have been provided at the end journals as a protection against possible derailment. The middle wheels being free to act through the flexible equalizing mechanism, do not require the protection of the inner coil springs, and only the heavy coils are used.

The middle journal boxes are guided by the side frames on their ends only. Clearance is provided between the upper portion of the boxes and the side walls of the frames to permit freedom of lateral movement of the middle pair of wheels on curves. When the middle journal boxes move laterally, an inverted pendulum motion takes place in the equalizing lever hangers, suitable provisions for this movement being made in the bearing surfaces of the hangers, keys and connecting parts.

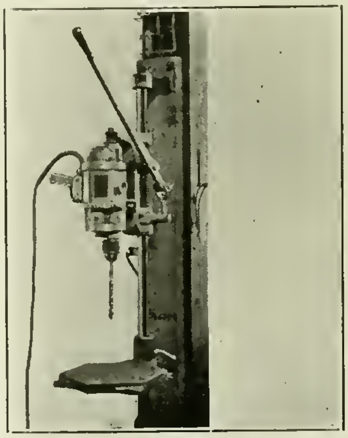
This truck has a wheel base 8 ft. 3 in., which is the shortest of any six-wheel truck yet developed. This has been an important factor in keeping down the weight of the trucks which, with the three-part bolster construction and clasp brakes, is 36,300 lb. per car. All parts of the truck are designed to carry a center plate load of 140,000 lb. and a 50 per cent overload on the side bearings without exceeding a fibre stress of 12,000 lb. per sq. in. All surfaces of contact between the journal boxes and the side frames are protected against wear by 3/16-in. hard steel liners. On the end journal boxes these liners are shaped to fit the top and sides of the boxes as well as the vertical flanges. For the middle journal boxes the liners are attached to the frame surfaces.

The truck has been designed for either clasp or single brakes. The trucks furnished for single brakes differ from those designed for the clasp brake rigging only in the shape of the side frames. For the single brake rigging the frames terminate at the outside spring pockets for the end journal boxes.

Adaptability Secured in New Post Drill

DETAILS of an application of Black & Becker portable electric drills to bench drill stands were given on page 740 of the November *Railway Mechanical Engineer*. Since that time the idea of the bench drill stand has been extended to make the stand attachable to a post or wall, whichever is more convenient. Standard portable electric drills of capacities from ⅜ in. to ⅞ in. are used in the new post or wall drill, and the principal change from the bench stand, previously described, has been to increase the length of the 1⅞ in. steel shaft and to arrange for holding it rigidly to the post by means of heavy brackets at the top and bottom. One other change has been in the arrangement for raising, lowering or swinging the table. All adjustments of the table are secured by means of the clamping screw shown in the illustration.

Attachment of the drill to the stand may be easily and quickly accomplished. As shown in the illustration, the brackets carrying the drill can be raised, lowered or swung around on the vertical column and secured in any desired position by means of a split collar and clamping screw. A strong spiral spring returns the drill to the high position when the feed lever is released. As both the drill brackets and drilling table have horizontal and vertical adjustments, the wall drill is an unusually flexible outfit, and for this reason is adaptable to a great variety of uses. It is made by the Black & Becker Manufacturing Co., Towson Heights, Baltimore, Md.



Black and Decker Post Drill

Specifications for the new post drill call for a column length of 46 in., vertical adjustment of drill 25¼ in., drilling radius 7 in., horizontal adjustment of drill 180 deg., feed by lever, 4½ in., and net weight 80 lb.

The extra long feed lever, illustrated, gives a feed ratio of approximately six to one, or in other words, a pressure of 80 lb. applied to the handle feeds the drill under 480 lb. pressure.

Rotary Wire Brush for Cleaning Operations

A ROTARY wire brush has been designed by the Independent Pneumatic Tool Co., Chicago, for use with the No. 71 Thor pneumatic grinder. It is interchangeable with the grinding wheel, an arrangement which in reality provides two tools in one, since the machine may be used either as a pneumatic grinder with a 4 in. emery wheel, or as a rotary wire brush for cleaning operations.

Thor Rotary Wire Brush Designed for Cleaning Operations

The face of the brush is 5 in. in diameter and, as shown in the illustration, all wires are of equal length, being hairpin shaped and made of specially treated steel. The concave back allows the wires to bend under pressure without breaking. By using this brush a large amount of time can be saved over that required by hand for the removal of paint, rust, scale, grit, etc. It is particularly useful on steel cars, tanks, frames, castings, sheet metal and other materials.

Duplex Compensating Suspension for Tractors

THE Baker R & L Company, Cleveland, Ohio, announces its new series C models of electric industrial tractors and trucks replacing the series B machines produced during the past three and one-half years. An important feature of the new machines is the ingenious manner in which the heavy thrusts of the axle and the driving and braking strains are resisted through what is known as the duplex compensating suspension. This suspension positively resists all torque and driving strain, provides for free spring action and maintains accurate alinement at all times between the axle and the frame.

Referring to Fig. 1, it will be seen that the axle is suspended by means of two V-shaped yokes through large ball and socket joints on the axle and trunnion bearings on the truck frame. The horizontal or driving yoke *A* transmits the driving power from the axle to the frame while the vertical or torque yoke *C* resists "torque" or the tendency of the axle to rotate and also has a slight forward and backward motion when compensating for the angular movement of the driving yoke.

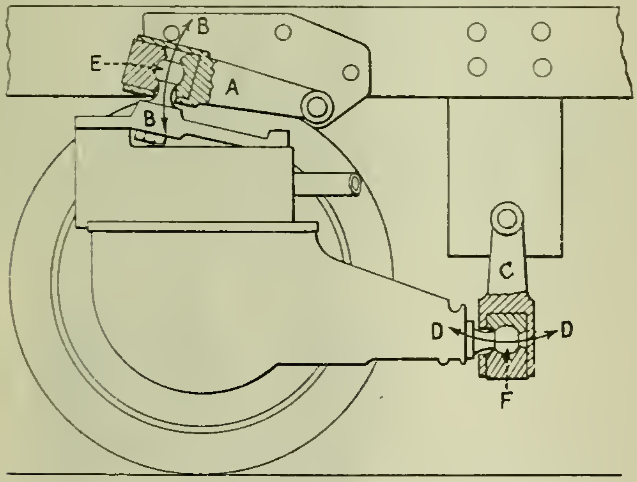


Fig. 1—Line Drawing of Duplex Compensating Suspension

The double concentric helical springs (not shown on the drawing) support only the truck load. They are loosely seated in the frame and axle members which are tied together against rebound with spring bolts, swiveling in their sockets. The flexibility provided by this construction permits the driving axle to negotiate either smooth or rough road surfaces, increasing traction without loss of power efficiency or clamping or binding the parts. Of equal importance is the elimination of maintenance expense, looseness and rattling when torque reactions are taken through sliding surfaces used in conventional constructions. The large, lubricated, trunnion bearings and adjustable ball and socket joints insure durability of parts for the life of the machine. A phantom view of the mechanism is shown in Fig. 2.

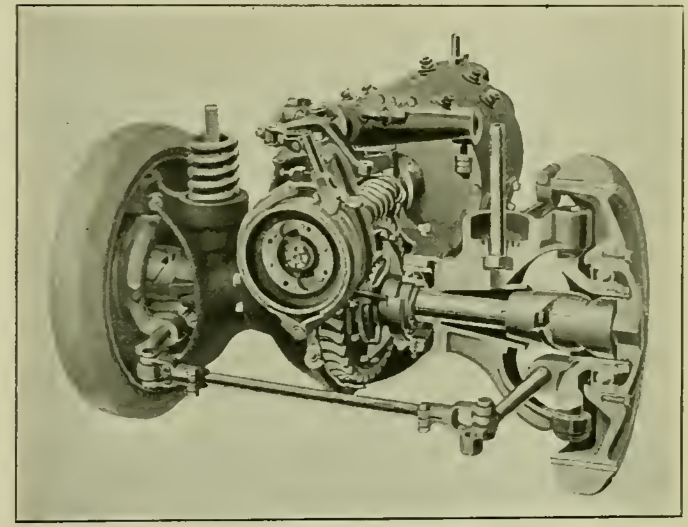


Fig. 2.—Driving Axle Equipped with Duplex Compensating Suspension

Emphasis is laid on the importance of the duplex compensating suspension because machines of the industrial truck type are subjected to extremely severe torque stresses. Although operated at slow speed they are frequently bumped into heavy objects and throughout their life must resist the

Fig. 3.—View Showing Method of Making Impact Tests

strains coming from abrupt starting and stopping. In fact, many operators change abruptly from full speed ahead to full speed reverse, subjecting the machine to heavier strains than are ever encountered in other vehicle work.

Sample machines incorporating this new feature were subjected to some unusual tests of a spectacular nature and stood up satisfactorily under strains which would easily have caused failure to trucks equipped with a less rugged and flexible type of spring suspension. In one of the tests a tractor, shown in Fig. 3, equipped with duplex compensating suspension was operated down a 12½ per cent ramp at 10 miles per hour as an impact test. The tractor struck a blow of 46 tons against the bumping post without damage to the spring suspension or other parts.

Automatic Valves Reduce Boiler Shut Downs

Modern power plants with their batteries of boilers, headers and many branch steam pipes, are susceptible to disastrous accidents and expensive shutdowns in the case of bursting boiler tubes or steam pipes. As a safety feature, the Golden-Anderson Valve Specialty Co., Pittsburgh, Pa., has developed an automatic, double-cushioned, triple acting, non-return valve for application in the main steam lines. The valve is entirely automatic in action, and in case of a split boiler tube or broken steam pipe, a reduction of pressure of 1 lb. or more below the pressure of the other boilers will cause the valve to close and isolate the boiler involved, thus allowing the other boilers to give uninterrupted service.

Should a break occur in a header or steam line, the valve on every boiler will instantly close, thus eliminating the havoc which would occur were the live steam from all the boilers permitted to escape through the break. It is also maintained that this valve equalizes the load between all the boilers automatically and makes possible the immediate location of a lagging or sluggish boiler.

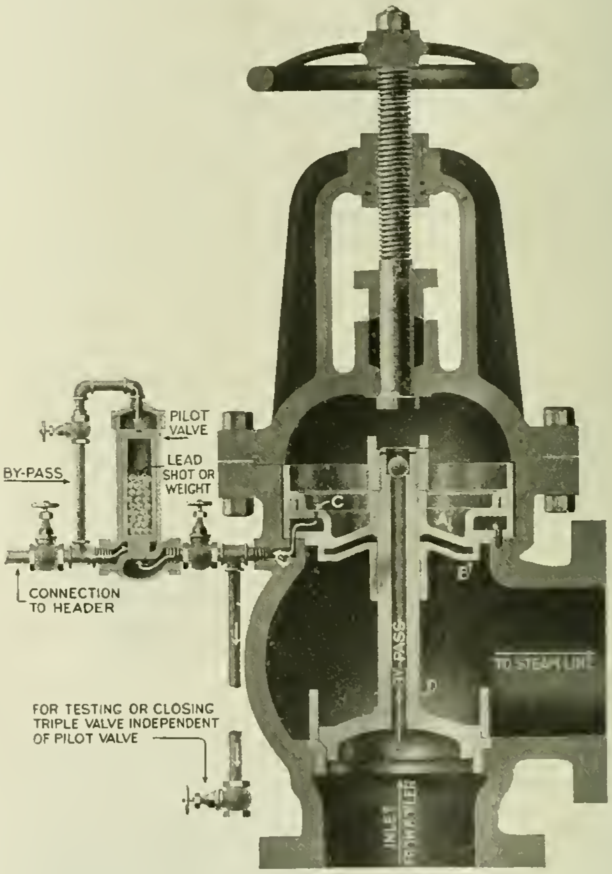
There is no need for hand operation as the valve automatically cuts in the boiler or cuts it out as the pressure equals or becomes less than the other boilers. If the steam gage should become defective and inaccurate the boiler cannot be cut in prematurely, as may happen with ordinary hand stop globe valves. At any time while in service under pressure the valve may be instantly tested or closed from the boiler room floor or other remote point.

The valve is fitted with special dash pots which provide against any hammering, pounding or spinning, and this feature assures smooth and durable operation. In the design of the valve. particular attention has been paid to provide adequate strength for the constant strain and vibration of a piping system. Perfect alignment is secured at all times and this prevents the binding and sticking commonly encountered.

Referring to the sectional view of the valve, it will be noted that the outside dash pot *B* is securely anchored to a shoulder of the valve body by numerous cap bolts. This dash pot acts as a cylinder for the inside dash pot *A* which is firmly fastened to valve disk *D* by a large lock nut. The design of the two dash pots affords a primary and a secondary cushioning (double cushion) effect which positively prevents any hammering or pounding. In case of an accident causing sudden closure of the valve, the double cushion allows an instantaneous drop of the valve to within ⅛ in. of the seat and then it closes smoothly under the control of the secondary cushion, preventing disastrous closure.

Automatic valves are usually placed on top of the boiler nozzle or installed in the steam line leading from the boiler; also in branch lines leading from the header. The automatic shot pilot valve is located adjacent to the main valve and piped into the header at about 15 ft. from the main valve on its outlet side. The automatic testing feature is connected between the pilot and main valve and extended to the boiler room floor. Boiler pressure is applied underneath the disk *D* and the valve, being balanced, will open automatically wheneven the pressure underneath the disk equals that above it. On reverse steam flow, as a result of less pressure beneath the disk *D* than above it, the valve will operate within 1 lb. variation.

In the case of a broken steam line or header with the valve working at 150 lb. pressure and the pilot valve set for 8 lb. differential, the instant pressure above the main valve disk drops to 142 lb. or less, it will permit the pilot valve to open and release the steam from between the dash pots. The main valve will then be instantly closed by the boiler pressure accumulating above dash pot *A* through by-pass in valve disk *D*, thereby shutting off all steam flow through the valve. The differential pressure may be decreased or increased by changing the weight of shot in the pilot valve. An 8 lb. differential is usually maintained which prevents premature closing or tripping on unusual steam requirements.



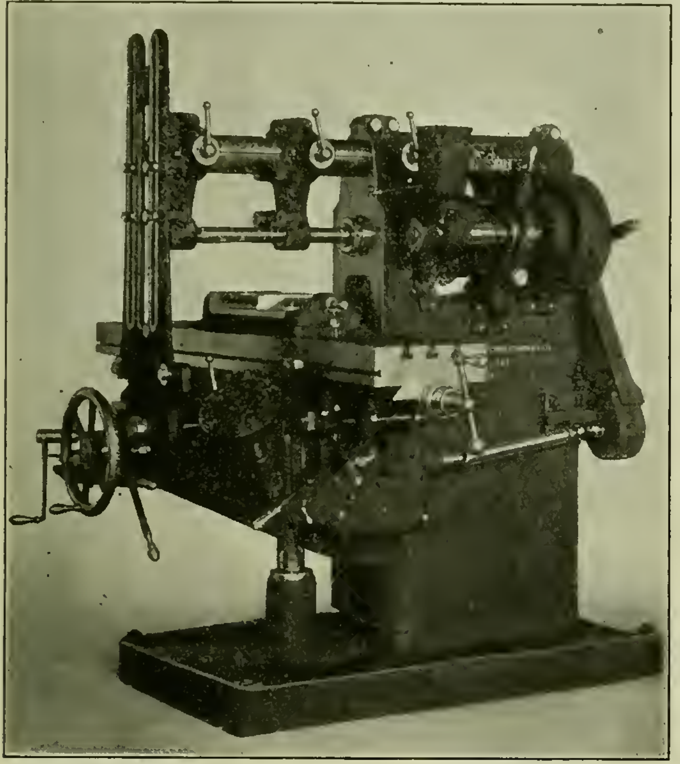
Golden-Anderson Automatic, Non Return Valve

The valve is equipped with a hand wheel and may be closed at any time like an ordinary stop valve. It will be noted, however, that the stem is not connected to the disk, but merely bears against it. Therefore, when testing a boiler hydrostatically the automatic valve can be left in automatic position, which allows it to float during the test and avoids strain on its parts.

An automatic valve should be tested automatically. By means of the automatic testing feature of this valve, it is possible to exhaust the steam between the dash pots at any time and determine whether the valve will close or not. The Golden-Anderson automatic valves are made in different sizes and several different patterns, including the angle pattern, globe pattern, vertical discharge elbow pattern, downward discharge elbow pattern, cross pattern, globe pattern for use where head room is limited, and others.

Cone Drive Plain Milling Machine

A NEW No. 4 plain milling machine with cone type drive has been developed recently by the Ford-Smith Machine Company, Ltd., Hamilton, Canada. As in the usual milling machine construction, special attention has been given to locating control handles for all movements of the knee and table within easy reach of the operator. In addition, rapid power traverse in all directions is secured, together with safety clips. An exceptional feed range, varying from .006 in. to 1.56 in. per revolution of the spindle, is provided. Rigidity of the knee is secured by eliminating holes in either the top or sides. A narrow guide is provided for the saddle on the knee. As shown in the illustration, a feed dial at the operator's hand indicates all feeds. Power feeds and automatic trips are arranged in all directions.


Ford-Smith No. 4 Plain Miller Equipped With Cone Drive

Special attention is called to the positive locking of the arbor supports on the overarm and of the overarm in the column. The column is of box section construction with heavy walls and bars for supporting the knee and bearings. Micrometer adjustments by means of graduated collars reading to 1/1000 in. are provided for the table screw, cross screw and elevating screw. The table is unusually stiff with wide bearings and great depth. The feed box is not carried on the column in the usual manner, but is bolted to an extension of the saddle on the knee. This construction makes possible the arrangement of the dial feed hand wheel, handy to the operator, at the working position at the front of the knee.

Twelve changes of speed are obtained from the dial which, in conjunction with the coarse feed handle at the side of the column, gives 24 changes when the back gear is in mesh. For ordinary work the feed is driven from the feed pinion geared to the spindle, but when the back gears are engaged the feed may be driven from the cone pinion, which speeds up the whole feed mechanism 3 to 1, or 10.8 to 1, according to the ratio of the back gear engaged, thus making possible exceptionally coarse feeds.

The rapid power lever must be held in position by hand while the rapid power is engaged, making the mechanism practically fool proof. As an extra precaution, however, a safety trip device is provided should the rapid power or feed overrun at any time. The countershaft is of the two-speed, friction type with self-oiling bearings. Friction clutches are of an improved expanding type carefully balanced with means of taking up wear.

Specifications for the Ford-Smith No. 4 miller call for a table working surface 71 in. by 14¼ in. Three ¾ in. T-slots are provided. The longitudinal, cross and vertical traverse are 42 in., 12 in. and 20 in., respectively. The distance from the face of the column to the base is 30 in. Eighteen spindle speeds, ranging from 14 to 450 r.p.m., are provided. The overarm diameter is 4¾ in., and the distance from the center of the arbor to the underside of the arm is 7¼ in. Twenty-four speeds are provided with the back gear in and 12 without the back gear. The feeds per revolution of spindle range from .002 in. to .39 in. for the cross and elevation. Rapid power traverse for the longitudinal, cross and vertical movements are at the rates of 130, 33 and 11 in. per min., respectively.

Gap Crane Saves Erecting Shop Headroom

ONE of the most formidable problems imposed in the design of modern locomotive repair shops is to provide a traveling crane capable of lifting a complete locomotive high enough so that it may be carried over the tops of other engines in the shop to be set down at some other point. With the rapid increase in the length and weight of locomotives, so that 90-ft. cranes are now common, this utility has added greatly to the cost of erecting shops. One feature that has been especially troublesome is the great headroom required. Thus, with adequate allowance made for clearance, the height of a locomotive on the floor, plus that of another one being passed over the top of it, plus the depth of the traveling crane and its trolley, gives a total height of 54 to 56 ft. or more from the floor to the underside of the roof trusses. This height is obviously a source of great expense in construction and is also a disadvantage in the operation of the shop because of the waste of heat, inefficient illumination and disadvantageous height to which the crane operator is removed from the floor.

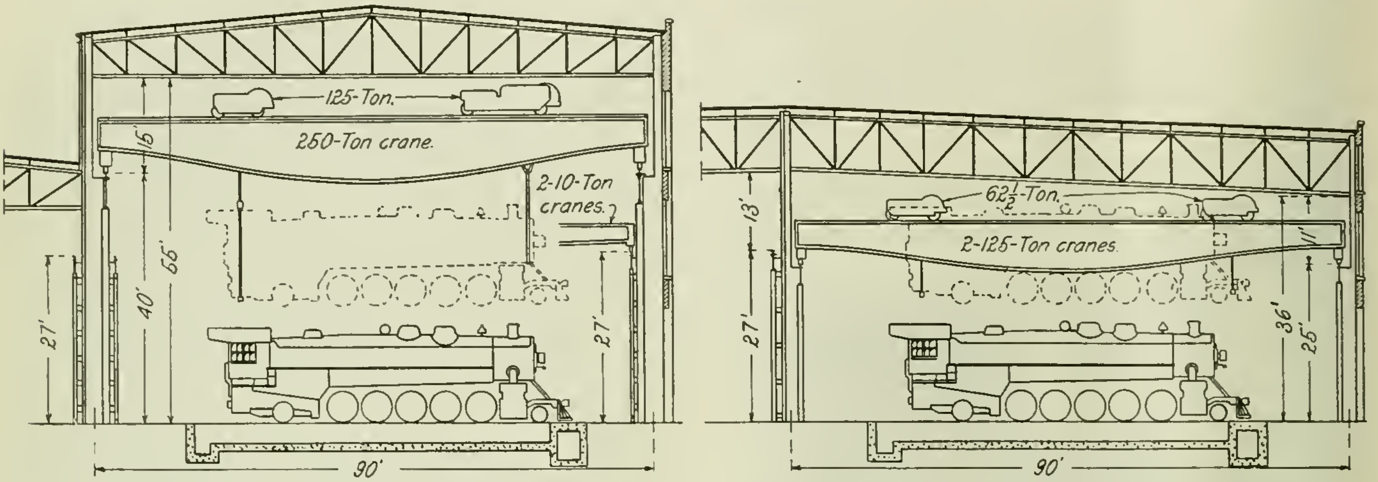
An appreciation of these shortcomings of the prevailing arrangement of shop structures has led to the development of the "gap crane" erecting shop by which from 15 to 18 ft. of the vertical height of the shop building may be saved. The idea is simple. The girders of the crane are spread apart a sufficient distance to permit the locomotive to be lifted up between them. As a consequence the crane may occupy the same vertical position as the locomotive, and the vertical height between the floor and the underside of the roof trusses consists of the height of the locomotive on the floor, plus the height of the locomotive in the air, plus the necessary clearance. The idea will be understood more clearly after an examination of the illustrations.

The gap crane is made up of four girders arranged in pairs with the two pairs separated a sufficient distance to allow the entire locomotive to be lifted up between them. Four trolleys of 62½ tons capacity each are used in pairs with the hooks or lifting devices at the ends of the fall lines attached to lifting beams which engage the front and rear ends of the locomotive. The lifting beam at the front end may be placed either under the extended sills or side frames which support the pilot truck or may be provided with adjustable saddle blocks and placed under the front end of the boiler, thus giving the same advantages as the sling rig but with greater resistance against overturning, a safety feature of importance.

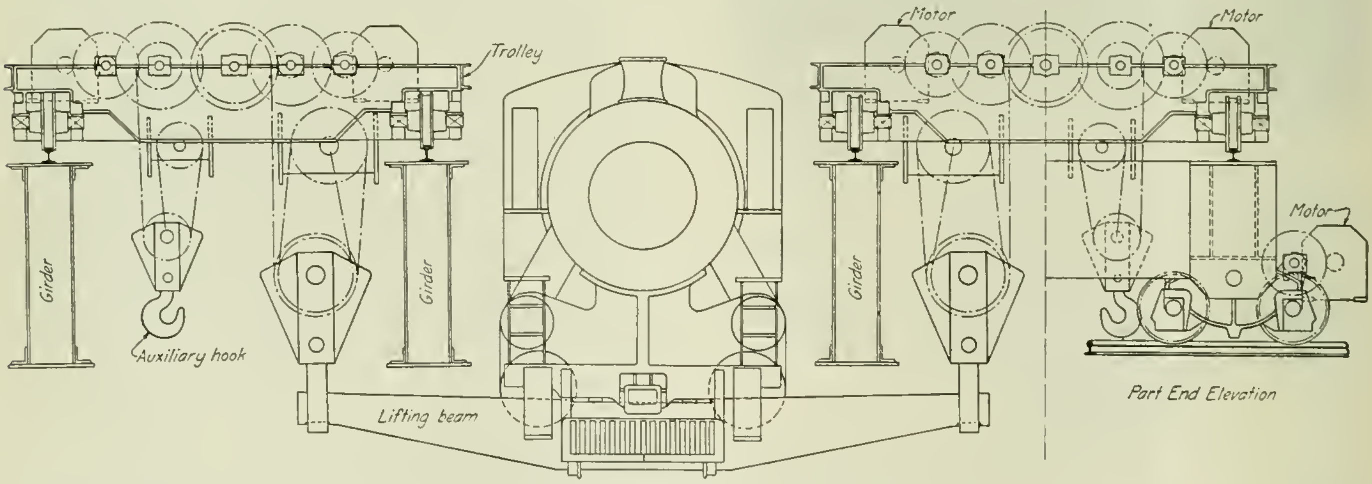
The gap crane may be constructed as a single unit or the two pairs of girders may be arranged to serve as independent "twin" cranes with provision for multiple unit control when they are used together for lifting a locomotive. Another feature of this development is the facility it offers for adaptation to old shops equipped with a crane of limited capacity. Thus, if a shop is equipped with a traveling crane of 120 or 125 tons capacity, a second crane of the same capacity may be provided and the two arranged to serve as twin cranes.

One point not to be overlooked in considering this development is the need in any modern shop of auxiliary or messenger cranes of 10 to 20 tons capacity. In the modern shop where high headroom has had to be provided for the lift-over operations, the auxiliary cranes have been usually operated on a separate runway about 27 ft. above the floor and therefore from 12 to 16 ft. below the runway upon which the large capacity crane is supported and thus the small cranes are enabled to operate without any appreciable interference with the large cranes. With the use of the gap crane in shops of 10 to 12 pits in erecting aisles, it is believed that the use of a single crane runway for both the heavy and light capacity cranes will work out very satisfactorily. With larger shops than this a more satisfactory arrangement would be to have the heavy cranes operated on a runway at an elevation of 24 to 27 ft. above the floor level and the light cranes mounted on a runway sufficiently high to enable them to operate over the tops of the heavy cranes. While this would involve some loss of the headroom saved by the use of the gap crane, it would accomplish a considerable saving in the cost of the steel frame of the building as compared with the case where the heavy section columns must be extended to the height necessary to support the heavy crane at the high elevation.

The idea of the "gap crane" erecting shop was conceived by Harvey Shoemaker, formerly superintendent of motive power of the Bangor & Aroostook, and construction work will be carried out by the H. K. Ferguson Co., Cleveland, Ohio.



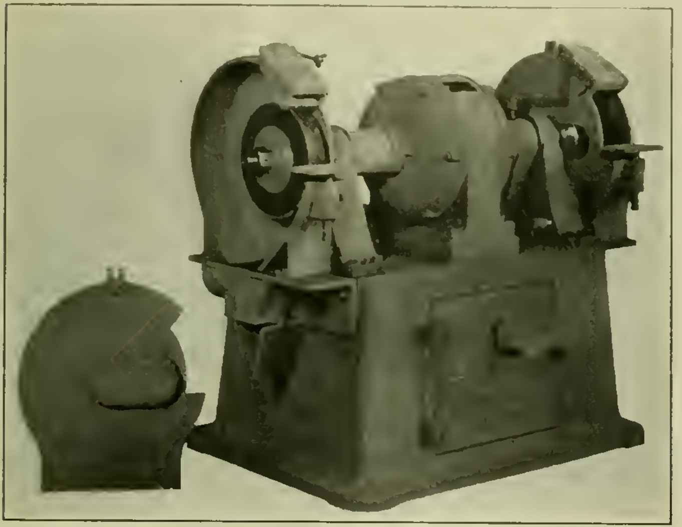
How a Gap Crane Reduces the Required Headroom in an Engine Shop



Cross Sectional Elevation of a Gap Crane

Heavy Duty Ball Bearing Dry Grinder

The Marschke Manufacturing Co., Indianapolis, Ind., has developed recently a No. 18 heavy duty, ball-bearing grinder, having four bearings. The machine is designed to swing either 18 in. or 20 in. by 3 in. wheels for dry grinding. The hood is adjustable, always bringing the wheel to the front of the hood, and an automatic control, spark plate adjustment is provided. The spark plate adjusts itself to the wheel as the steady rest is adjusted to the wheel by moving the hood. This is done by one hand wheel, no tools being required.


Marschke No. 18 Ball Bearing, Dry Grinder

The machine, illustrated, is provided with an exhaust fan, mounted inside the base. The fan operates on S. K. F. ball bearings and runs by means of a silent, high speed chain, all parts being enclosed in a housing kept free from dust and grit. The machine is equipped with or without an exhaust fan, as may be desired. The starter is mounted on the back of the door and opens with the door, permitting access to the blower. The machine is furnished with either a handle or push button starter. The hood support, which is also the outer ell for the exhaust, is equipped with an opening directly underneath the hood and answers for several purposes. It is used as a clean-out, and, when grinding brass, can be opened, the heavy brass particles being collected in a container underneath. This construction enables the brass particles to be saved and sold with other brass scrap.

Specifications for the new 18-in. dry grinder call for a 7½ hp. motor drive. The distance from the floor to the center of the arbor is 34 in. and the floor space required is 32 in. by 64 in. The speed of the motor under no load is 1,200 r.p.m.; under full load, approximately 1,160 r.p.m. When direct current motor drive is desired, a B. F. Sturtevant motor is applied and when alternating current is desired a Marschke motor, designed especially for this work, is used.

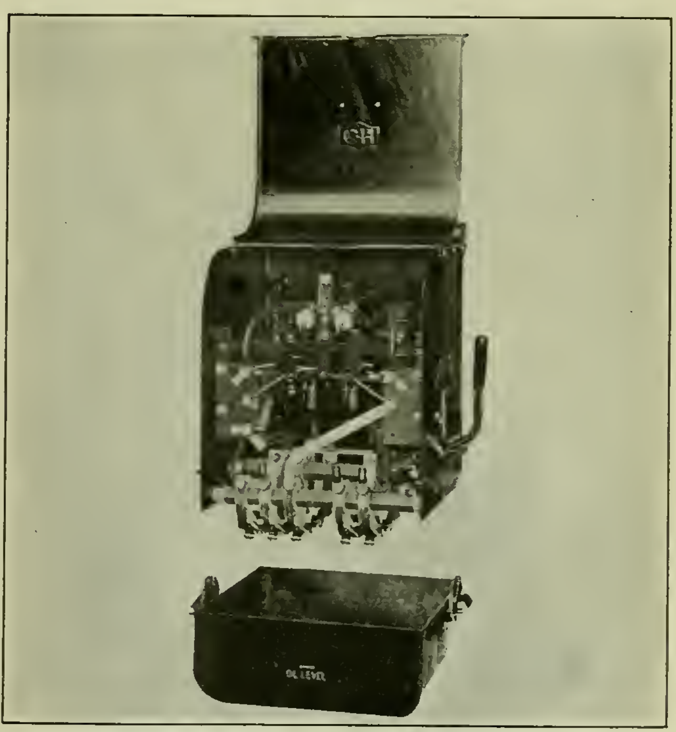
Rigidly Constructed Auto-Transformer Starter

The engineering department of The Cutler-Hammer Mfg. Co., Milwaukee, Wis., has devised an auto-transformer starter of unusually rigid construction to meet the severe requirements of the large industrial plant and mine, as well as that of the small mill and factory. The simple steel construction—using no wood or castings whatsoever—the absence of flexible moving leads, and the ease of inspection of the contacts and adjustments of the relays, enable this starter to give continuous and satisfactory service at a low upkeep cost. This starter, which is shown in the illustration, consists of two auto-transformers, commutating mechanism, low voltage release and duplex overload relay, all enclosed in a sheet metal case with the operating lever outside. The case is strongly reinforced with angle iron, and has a hinged cover which can be lifted to expose the transformers and relay. The transformers and case are carried directly on the supporting brackets and may be readily mounted on the wall, switchboard, or any post or pedestal.

The starter is operated by moving the operating lever forward to the starting position and then backward to the running position, where it is held in place by the low-voltage mechanism. Interlocks prevent moving the lever directly to the running position. If released in the first or starting position, the lever is returned to neutral by a spring. Locked in the neutral position it prevents unauthorized operation.

Two auto-transformers connected in open delta are used for both two and three phase service. The special construction of the transformer core allows either coil to be easily and quickly replaced. Each coil is provided with three accessible taps which give 50, 65 and 80 per cent of full line voltage.

The low-voltage mechanism is mounted inside the case on the right-hand side. A wire from the armature of the release coil extends through the case near the operating handle and is bent to form a hook, a slight pull on which releases the starter and returns the handle to neutral. Remote control of stopping may be obtained by inserting one or more normally closed pushbutton switches in the low-voltage circuit. Any push button will release the starter mechanism.


Starter With Oil Tank Lowered and Cover Thrown Back

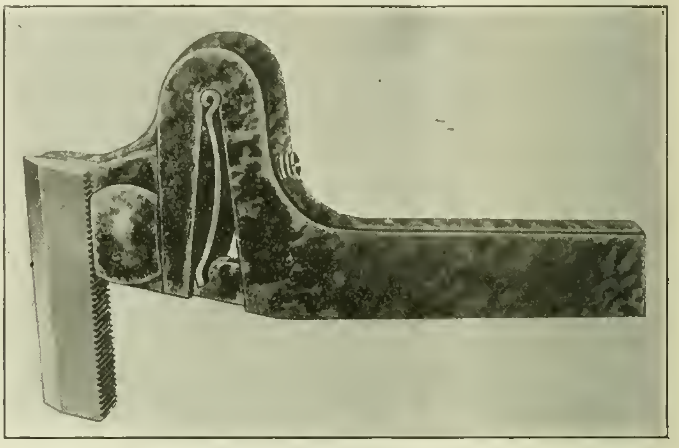
A duplex overload relay with a true inverse time limit movement is mounted inside the case on the transformer assembly in such a position that adjustments for time and current values can be readily made. This duplex relay is equivalent to two overload relays, each in series with one of two phases. The underwriters' rules do not require the installation of a disconnecting knife switch or circuit breaker ahead of this starter when thus equipped, because the starter completely disconnects the motor from the supply line when released by an overload.

These starters are made in various sizes for the operation of two or three phase induction motors rated between 5 and 100 hp. on standard commercial voltages between 110 and 2,200 and at frequencies of 60, 50, 33 and 25 cycles per sec.

Spring Threading Tool of New Design

THE old goose neck principle is incorporated in a new threading tool made by the Ready Tool Company, Bridgeport, Conn., for the purpose of eliminating chatter and to enable the operator to cut smooth threads on all lathe work. The cutter is held at an angle of 15 deg. and the side angles are accurately ground so as to cut a practically perfect 60 deg. thread. The cutter, being held on the left side of the holder, enables the operator to work close up to a shoulder. The spring allows threaded work to be finished smoothly and as only high speed cutters are provided threading can be done at high speeds.

Notched teeth are cut in the back of the cutter and in the front of the dog, the two being clamped together with a bolt holding the dog to the tool holder, which overcomes any possibility of the cutter slipping. An auxiliary spring with a set screw is incorporated in the holder and by increasing the pressure, heavy pitches, such as four, six and eight, can be cut just as smoothly as the finer ones, in which latter case the auxiliary spring is released.

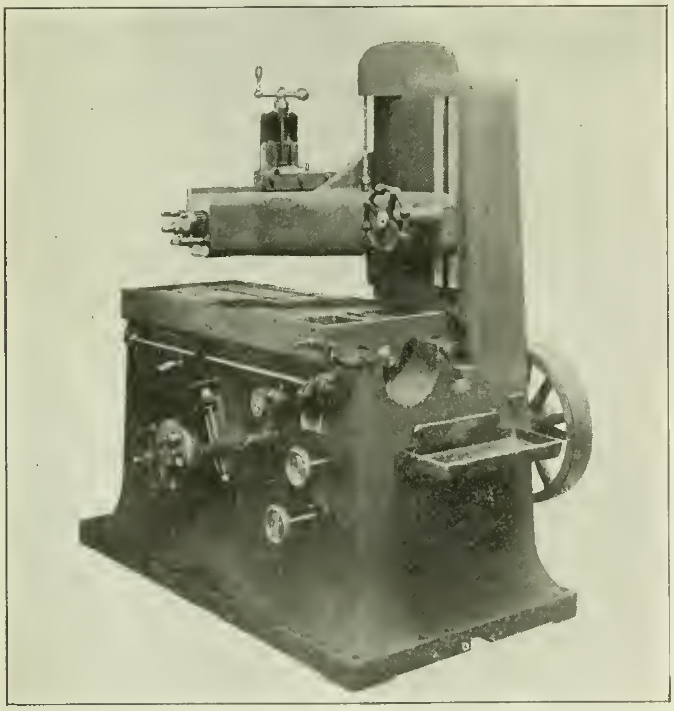


Ready Spring Threading Tool

Only the top surface of the cutter requires to be ground, thus assuring long life for the tool and accurate threads. A Woodruff key in the bottom overcomes any possible side thrust. "V" cutters as well as U. S. standard pitches and chasers are carried in stock for immediate delivery. This tool is made in right hand offsets, size ½ by 1 by 7 in.

Combination Clutch Brake for Shaping Planer

THE latest type of Coulter shaping planer, built by the Automatic Machine Co., Bridgeport, Conn., is shown in the illustration, and a noteworthy feature in its construction is the combination clutch brake mechanism. This is operated from the front of the machine, and enables the table to be stopped and started instantly without changing the motor or countershaft speeds. In fact, with this arrangement, no countershaft is necessary on the belt-driven model, as it can be belted directly to the main line shaft, thereby saving space where head room is limited. A length of stroke indicator is also provided together with clamps for clamping the down feed while the cross feed is working, or vice versa. These features are especially desirable for many tool room machine operations.



Coulter Shaping Planer Equipped With Clutch Brake

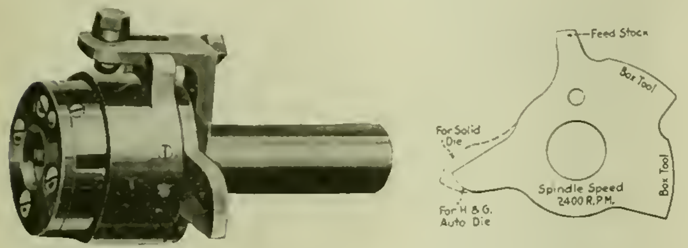
The clutch brake mechanism consists of a raybestos lined brake and a main driving pulley made up of two concentric wheels, the inside rim of one and the outside rim of the other being bevelled at an angle which by repeated tests has been shown to be most satisfactory for the purpose. Movement of the operating handle to throw out the clutch applies the brake simultaneously. There is a split nut on the driving shaft so that the amount of friction in the clutch can be adjusted. The large bearing surface and large diameter result in a minimum of wear, maximum torque for a given pressure and absence of appreciable heating. The whole arrangement is simple, with few parts to get out of order, a valuable feature for any machine in railroad shop use.

Other features, making the new Coulter planer of especial interest, are the shaper advantages of quick return stroke, variable speeds and ability to cut to a shoulder, with planer accuracy and table capacity. The maximum stroke can be taken with the same accuracy as a shorter one, and this maximum stroke can be taken anywhere on the table by merely positioning it under the tool without disturbing the work.

Redesigned Trip Levers for Die Heads

THE Eastern Machine Screw Corporation, New Haven, Conn., has developed a new self-opening die head for use on Brown & Sharpe automatics, which is said to practically double the production of button dies. The principle by which the chasers are held and operated with the positive bearing directly over the cutting edge is the same as in all H. & G. die heads, but changes have been made in the method of drive and in the design of the trip lever, as shown in the illustration.

Previously the head was kept from turning in the floating shank by a pin through the shank proper engaging and traveling in diametrically opposite slots in the floating shank. As redesigned, this is accomplished by an extension on the shell of the head which engages both sides of the arm of the floating shank that overhangs the body. This brings the drive further from the axis of the die head and decreases the friction to a negligible quantity, with the result that the coarsest pitch which the machine will pull is threaded without friction or cramp in the head.



Style D. H. & G. Die Head with New Method of Drive and Trip Lever

At the same time the design of the trip lever has been changed to make it sensitive for the finest threads up to 90 per in. These changes make it a simple matter to install the new heads on any Brown & Sharpe automatic.

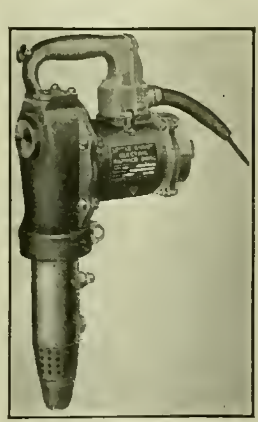
The layout of the cams is much simplified, inasmuch as they do not have to conform to the lead of the screw either on the advance or reverse, simply starting the thread and advancing the turret somewhat less than the amount of the lead, after which the die head pulls out and trips at the proper point.

The adjustment for length of thread is accurately made by an adjusting screw which brings the tripping button to the proper point. With this head it is possible to cut to a shoulder or a given point with great precision and simple adjustment is provided for the depth of cut which can be controlled to less than .0005 in. By the use of these die heads, it is possible to obtain an additional speed, inasmuch as the reverse belt can be used for forward driving at a more favorable speed.

The illustration shows a cam outline and compares the solid die cam with the self-opening die cam, showing that the change is very simple. This particular cam is threading at 2,400 r.p.m. One cam can be used for threading many different pitch screws. High speed steel chasers, provided with the proper clearances, produce straight, smooth threads at extremely high speeds.

Electric Hammer Drill of Novel Design

A HAMMER DRILL, driven by an electric motor instead of compressed air, is being manufactured by the Chicago Pneumatic Tool Company, New York. The drill is known as the Little Giant electric hammer drill, and is said to be particularly adapted for drilling concrete, soft stone and for light chipping of metals. The hammer blow, which is delivered by a piston on the drill steel or chisel, is produced by pneumatic impact. At the instant the blow is struck, the piston is running free of all mechanical parts and very little shock or vibration is transmitted to the electrical parts of the tool. The tool is so balanced that when held loosely in the hand, the line of center of gravity falls between the third and middle fingers of the hand and lies within the barrel of the tool, causing the tool to hang vertically and be easily controlled. The switch is located in the handle. All bearings are of the ball type and provision is made for the lubrication of all revolving and reciprocating parts. The gears and other portions of the moving parts subject to wear are all hardened. A universal type of motor is used which will operate either on direct or alternating current and motors will be supplied for either 110 or 220 volts



Electric Hammer Drill

A special feature of this drill is a live air device for clearing the hole of the cutting while drilling. The purpose of this device is to keep the hole clear, so that when holes are drilled in stone or concrete in a downward position the air will dispose of powdered cuttings which absorb and waste much of the force of the blow and tend to choke up the hole. This makes it possible not only to deliver the full force of the blow on the stone or concrete, but makes it easy to get the drill bit out of the hole. Hollow steels or bits are furnished for this purpose.

The efficiency and convenience of electric operated tools are well known and the Little Giant hammer drill marks one of the first attempts to operate a hammer by electricity.

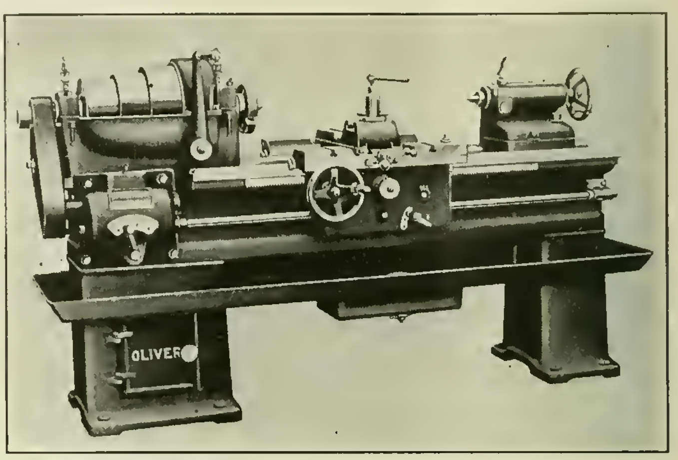
Fibrous Metallic Packing for General Use

FOR packing reciprocating, or revolving rods, glands, cocks and valves of all kinds, a metallic packing known as "Red Seal" has been introduced to the American market by General Engineering Accessories, Ltd., London. The feature of particular interest about this packing is its physical composition. It is a plastic metallic composition, "a fibrous mass, composed of 88 per cent impalpable powder of special alloy so fine as to pass through a sieve with 10,000 meshes per square inch." The packing is readily broken up by hand and can be kneaded, a characteristic which enables it to be packed into a gland of any shape and be distributed evenly. Tightening the gland compresses the packing together until it becomes a metallic ring, stated to be practically as impervious as a collar of steel. At the same time, due to the exceeding fineness and structure of the alloy, it cannot score the rod or stem which it surrounds. The use of a small quantity of cylinder oil mixed with the packing will facilitate packing inverted glands or glands in awkward positions.

Advantages claimed for Red Seal Packing are that it never scores or tapers a rod, never burns or gets hot, is equally efficient for superheated steam, hot or cold water, tar or ammonia, requires no skill to apply, does not harden, is self-lubricating and obviates the necessity of keeping a range of sizes in stock. It is being sold in this country by John Simmons Company, New York.

Simplicity Features New Oliver Lathe

After working on its design for several years, the Oliver Machinery Co., Grand Rapids, Mich., has developed a new 16-in. rapid production lathe, of which perhaps the most notable feature is its comparatively simple construction. By the elimination of more or less non-essential working parts and by strengthening the lathe at points subject to heavy working stress, a high production tool has been developed, which is now giving satisfactory service in several plants.

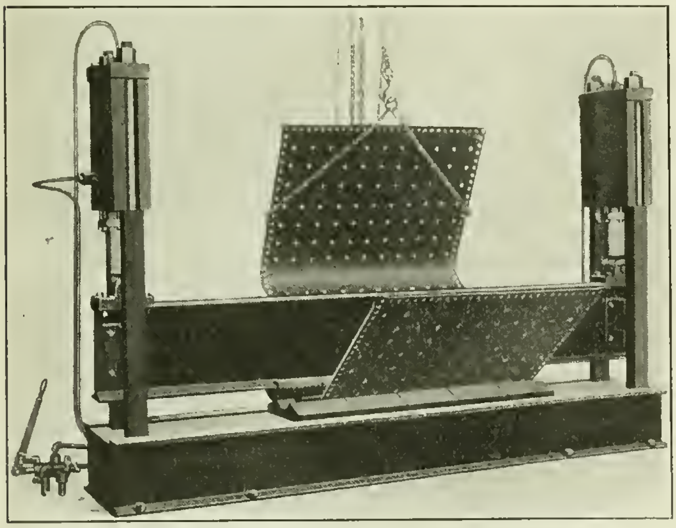


Oliver 16-In. Production Lathe

The simplest form of the lathe with a 3-step cone pulley headstock is shown in the illustration. The driving cone is large in diameter and each step of the cone is wide. This allows for a powerful drive at comparatively high speed. The large lever shown in the front of the headstock operates the starting and stopping clutch. The efficiency of this clutch and the ease of operating the lever are important elements in securing rapid production. The headstock may be furnished with double back gears or with single back gears, as desired. Four feeds are provided through the quick change gear box. The tool post is mounted on a carriage of substantial construction, as shown. Provision is made for a continuous flow of cutting compound at the cutting point. All working parts are carefully guarded.

Plate Press With Sectional Dies

A plate press designed for use with sectional dies has been developed by the Houston, Stanwood & Gamble Co., Cincinnati, Ohio. The machine consists of a simple arrangement of cross-beam, connected to rams at each end by bearings, having swivel pins which give the beam flexibility, and allows it to adjust itself to any unevenness of the work. The frame consists of heavy uprights, bolted through substantial cylinders at the top, and bolted through a heavy reinforced base casting at the bottom. The upper sectional dies are placed on the beam of the machine in a simple manner. A bar extended through a hole in each die enables it to be lifted by two men and slipped on at the end of the beam. It is then moved along to any position which may be desired.



Sectional Dies Produce Accurate, Interchangeable Work

The lower sectional dies are placed on the bed of the machine and aligned with the upper dies by means of the side channels which reinforce the bed. These side channels extend above the heavy base casting for that purpose. The operating lever for controlling both working and return stroke is conveniently located and is always within easy reach of the operator. The entire upper part of the machine is flexible to a necessary degree which takes care of any uneven strains and stresses during the working stroke.

The operation of bending a wrapper sheet is shown in the illustration, and the press is particularly adapted for this class of work, the work possessing the added advantage of interchangeability. The machine is built in various sizes and capacities, and is designed to operate by hydraulic or compressed air pressure.

Headlight Combines Strength and Lightness

The American Metal Products Company, Brooklyn, N. Y., has put on the market under the trade name "Ampro" a new electric headlight cast from a specially strong non-corrosive metal. The headlight weighs complete with mirror glass reflector 45 lb. On account of its light weight one man can install the "Ampro" without the use of tackle or special rigging.

Some of the features claimed for this new lightweight headlight are its weather tight and air tight construction; interchangeable straight and angle side number doors; improved latches which keep the doors intact under severe vibration; 14-in. mirror glass reflectors giving the maximum illumination required by the Interstate Commerce Commission; a new improved positive focusing device so constructed as to insure against breaking or bending of wires; and a specially designed positive electrical contact block which, when once wired, stays wired.

The "Ampro" headlight is readily fastened to the bracket on the smoke box door, or wherever it may be located, by means of four bolts through the legs.

Improvements in Twist Drill Grinder

The original New Yankee twist drill grinder, as made by the Wilmarth & Morman Co., Grand Rapids, Mich., was an improvement over previous types because preliminary calipering was eliminated, and positioning of the drill made entirely automatic. The only adjustment required was the setting of the tailstock for the various lengths of drills. This style of drill grinder, adapted to the grinding of straight shank drills only, remained standard with the Wilmarth & Morman Co. until the advent of taper and collared shank drills made a special attachment necessary.

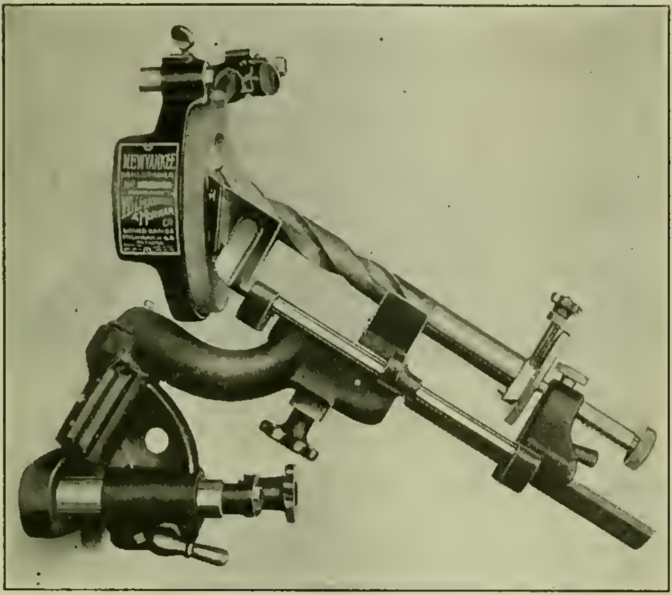


Fig. 1—Method of Holding Long Straight Shank Drill

The recently improved New Yankee drill grinder is provided with a new attachment by means of which straight and taper shank drills can be readily ground without any time consuming adjustments. The operation of the grinder is shown in the illustrations. Figs. 1 and 2 illustrate how long, straight and taper, collared shank drills, respectively, are positioned. When the body of taper and collared shank drills becomes too short to be supported by the sliding V block, Fig. 2, this part is thrown out and the shank of the drill is supported by a center detail in the elevating tailstock. Fig. 3 shows how a short, straight shank drill is positioned in the holder for grinding.

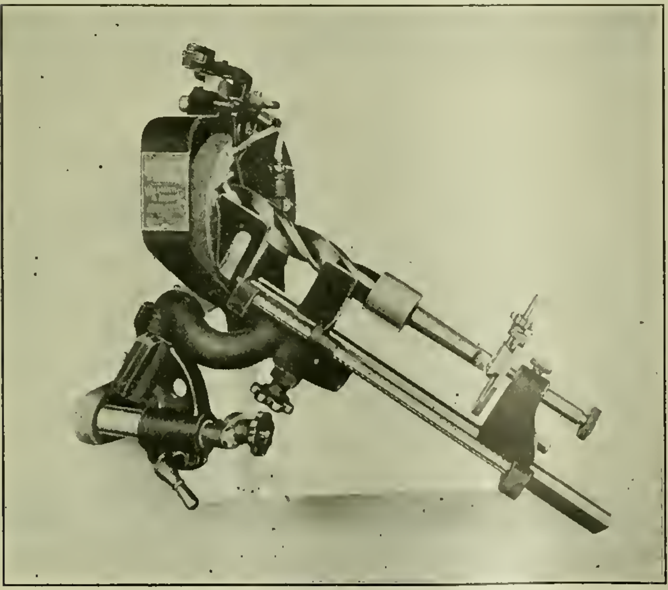


Fig. 2—Grinding a Taper, Collared Shank Drill

Nine belt and eight motor-driven styles of twist drill grinder are offered. These are made up in different combinations from four holders having the following capacities: No. 52 to ⅝ in., 3/32 to 1½ in., ¼ to 2½ in., and ½ to 4 in. Each machine is equipped with means for obtaining different clearance angles and includes a built-in wheel truing device.

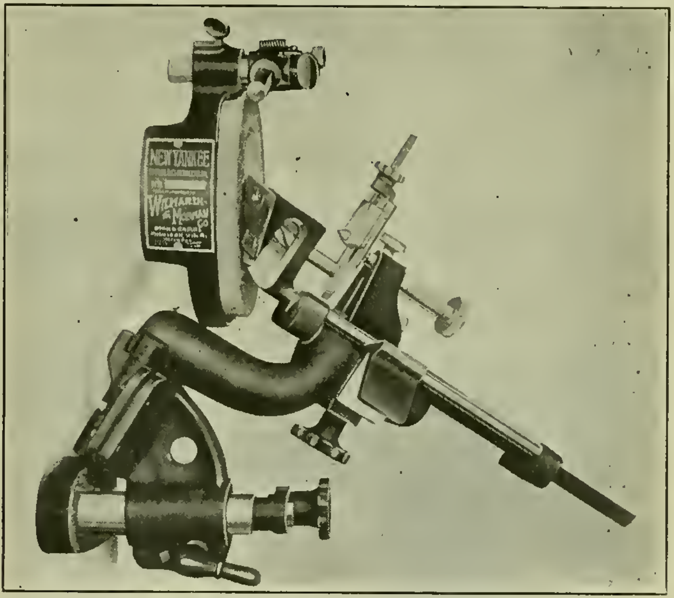


Fig. 3—Grinding a Short Straight Shank Drill

On account of the voluminous amount of drilling work in railway shops, twist drill grinders are an essential part of the toolroom equipment. The shop managements should not be content, however, to operate old style grinders when grinders with improved attachments are available. Especially when these attachments make possible a more accurate grinding of drills or when they allow for the grinding of short taper, or collared shank drills which would otherwise have to be ground by hand they should be installed. The aggregate saving due to their use will in the long run pay big dividends on the money invested.

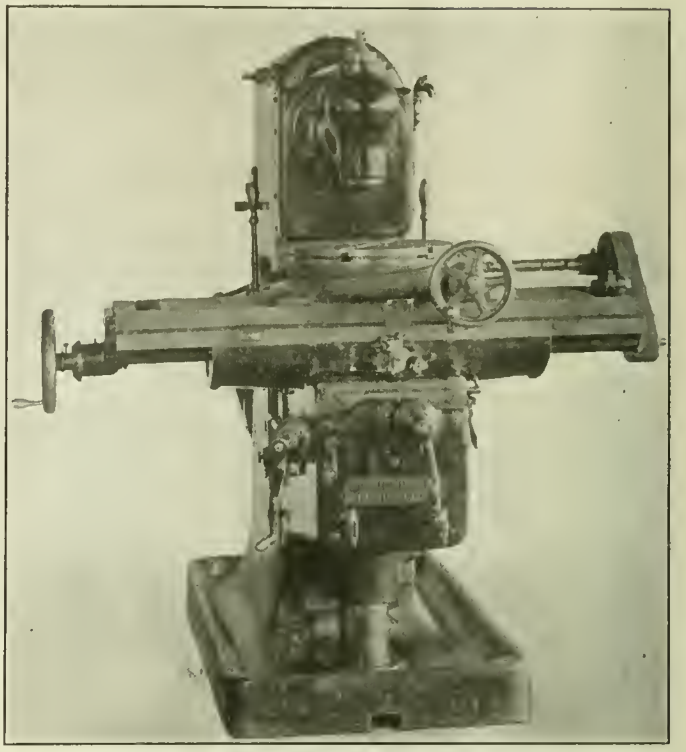
It is obvious that a shop or roundhouse so small as to require only the occasional use of twist drills could not afford the installation of a twist drill grinder, but in most cases the drilling requirements are large. Many drills of all different kinds and sizes have to be maintained in good working condition and, with the obvious inefficiency of hand grinding, the use of modern, improved twist drill grinders is advisable.

Rotary Table for Milling Machines

The rotary table as designed for Cleveland milling machines, made by the Clark-Mesker Company, Cleveland, Ohio, can be operated either by hand or power feed. There are sixteen changes of feed, controlled from the front of the knee in the same way as the other feed movements of the table. The direction of rotation may be reversed by using the feed reverse lever in front of the knee. The feed drive is taken from the table feed drive gear, connected by telescopic sleeves to a gear case on the end of the table. From this point a shaft extends and drives a pair of bevel gears which drive the work shaft. The worm is cut with a coarse pitch and runs in oil. The end thrust is taken care of both ways by large ball thrust bearings and means are provided for taking up the wear.

The worm wheel is accurately cut and is made sufficiently large to allow heavy cuts to be taken on the circumference of the table. The rotary table is liberally provided with T-slots of the same size as those in the milling machine table. An automatic trip for releasing the power feed at any desired point is provided. The circumference of the table is graduated in degrees for obtaining angular settings. The table has a tapered center hole to accommodate a short taper arbor for centering gears and other work as well as for clamping the work.

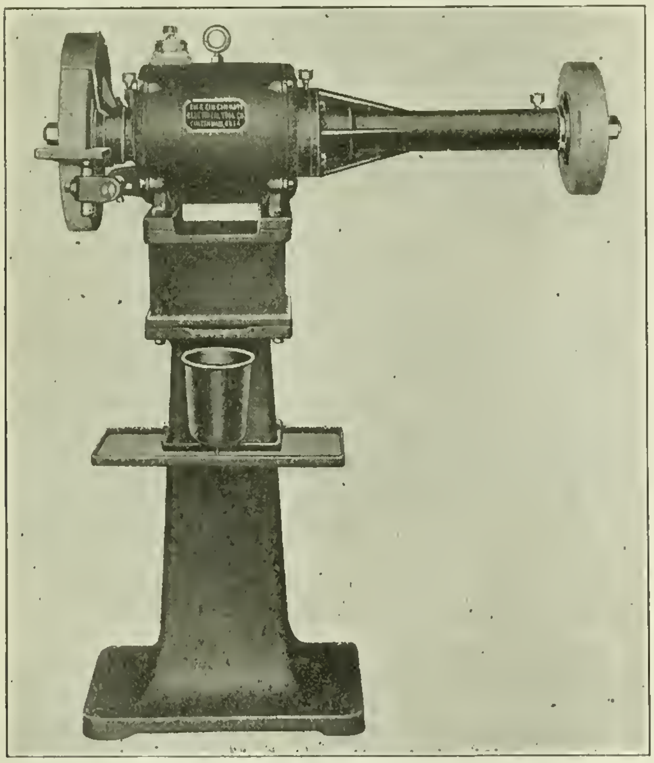
This rotary table attachment may be used for cutting large gears, sprockets, etc., or it may be used for dividing, when furnished with a crank and index plates. Index plates and crank, however, are not regularly furnished with the attachment.



Rotary Table Applied to Cleveland Milling Machine

Combination Grinding and Buffing Machine

A combination floor grinder and buffer which permits interchangeable buffing and grinding without the common delay of changing wheels, is the latest product of the Cincinnati Electrical Tool Company, Cincinnati, Ohio. The new machine is arranged with both grinding and buffing wheels, the grinding wheel being adapted to tool grinding and general grinding on all kinds of miscellaneous work.



Cincinnati Combination Grinder and Buffer

The motor windings are fully enclosed and protected and spindles are carefully ground. Annular ball bearings are fitted on both ends of the armature spindle, as well as the end of the extension spindle. Dust caps, fitted to the spindle, protect the bearings and windings from emery dust and dirt, thereby increasing the life of the machine.

The grinders are fully equipped, including tool board and water pot, and can be furnished without floor pedestal if desired.

The motors are made for direct or alternating current in ½, 1, 2 and 3 h.p. capacity to carry wheels from 8 to 14 in. in diameter.

Change in Safe End Taper

The Coleman tube safe end, as described on page 127 of the February *Railway Mechanical Engineer*, is shown to be held against movement towards the firebox by a square shoulder and against movement in the other direction by a taper end, beaded over. The taper, indicated, was 2¼ in. per ft. but experience shows that this amount is greater than necessary and a taper of 1½ in. per ft. has been adopted as standard.

Attention is also called to the statement on page 128 that the Coleman safe end requires about 10 per cent less working than the prossered safe end. In reality this should read 90 *per cent less* since the original statement was that Coleman safe ends require about 10 per cent *of* the working necessary with prossered safe ends.

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WE GUARANTEE, that of this issue 9,200 copies were printed; that of these 9,200 copies, 8,253 were mailed to regular paid subscribers, 8 were provided for counter and news company sales, 265 were mailed to advertisers, 32 were mailed to employees and correspondents, and 642 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 40,200, an average of 10,050 copies a week.

The *Railway Mechanical Engineer* is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.)

Fire, early on the morning of February 16, destroyed a two-story shop building of the Missouri Pacific at St. Louis, Mo.; estimated loss, $100,000.

Senator Cummins, chairman of the Senate committee on interstate commerce, announces that he proposes to introduce at the beginning of the next session of Congress a bill providing for the compulsory consolidation of the railroads into 14 to 18 systems.

Eight thousand is the number of members of the National Safety Council who own or operate shops or other industrial plants; and the officers of the council propose to proprietors to conduct intensive campaigns, for some particular feature of safety, in all of these plants during one month throughout the year; a month to each feature. January was devoted to special efforts to prevent ladder accidents; February to infections arising from minor injuries, and March to unsafe clothing. For April the program is horse play.

Senator La Follette's speech in the Senate on February 21 and 22 in opposition to the passage of the Winslow bill has just been published in the Congressional Record, and, with the appendices, takes 64 pages, mainly in small type. The appendices consist largely of charts showing interlocking directorates and various statements presented by the labor leaders to the Railroad Labor Board at Chicago in connection with their charges that railroads have paid extravagant prices for car and locomotive repairs in outside shops.

A bulletin issued by the Bureau of Labor Statistics of the United States Department of Labor on employment in selected industries in January, 1921, summarizes reports from 46 car building and repairing establishments which in January, 1921, had on their payrolls 44,613 employees, or 5½ per cent less than for January, 1920. The amount of the payroll in January, 1921, however, was $3,125,082, or 9.6 per cent greater than that for January, 1920. A similar comparison for January, 1921, and December, 1920, is given for 45 establishments, which shows a decrease of 12.4 per cent in the number of employees on the payroll and a decrease of 20.2 per cent in the amount of the payroll. The bulletin states that the industry reports that in order to reduce expenses and on account of the general business conditions the number of employees was reduced. The per capita earnings for the period in January were 8.9 per cent lower than for the December payroll period.

R. V. Massey, chairman of the newly organized joint reviewing committee of the Pennsylvania Railroad, says that the committee already has successfully disposed of, to the satisfaction of both sides, eight controversies which have been pending a long time, one of them since 1914. To emphasize the fact that the committee is a united non-partisan body for the judicial and impartial settlement of differences and not a mere conference between representatives of opposing sides, it has been decided that at the meetings no two representatives of the management or of the employees shall be seated together, but that they shall be alternated around the table. Mr. Massey is "confident that every member of the committee, whether representing the men or the management, is keenly alive to the responsibility resting upon him; and equally confident that not one of the committee has the slightest doubt of the ability of this body to adjust on a fair and friendly basis any differences which may arise affecting the employees represented."

Inspection of Railway Stationary Boilers in Canada

The Board of Railway Commissioners for Canada has ordered that the railway companies subject to its jurisdiction put in force not later than June 1, 1921, regulations promulgated by the board for the inspection of railway steam boilers other than locomotive boilers. The orders cover the design and construction of the boiler and appurtenances and provide for periodical inspection.

Boiler Inspection Act Does Not Apply to Locomotive Cab

The New York Appellate Division holds that the Federal Boiler Inspection Act, requiring locomotive boilers and appurtenances to be kept safe, does not apply to a locomotive cab, so that sections 3 and 4 of the Employers' Liability Act, precluding the defenses of contributory negligence and assumed risk, where a safety act is violated, do not deprive the railroad of these defenses in an action for injuries caused by a depression in the floor of the cab. A cab is not appurtenant to a boiler, and the intention of the act was to guard against accidents peculiar to boilers.—Brown *v.* L. V., 191 App. Div. 691, 181 N. Y. Supp. 800.

No Exhibits at June Conventions

The Railway Supply Manufacturers' Association at a meeting of its executive committee at Pittsburgh, Pa., voted against having an exhibit at the convention of the American Railway Association, Division V—Mechanical—in June.

Further details relative to this decision are given in a letter sent to members of the association, dated March 10 and signed by J. D. Conway, secretary, and J. F. Schurch, president. The letter follows:

> After a thorough canvass and study of the entire situation, both among the manufacturers composing this organization and the railroad executives, your executive committee has unanimously decided it the part of wisdom

> and good business judgment to postpone the June, 1921, R. S. M. A. exhibit at Atlantic City for the following reasons:
>
> 1. We are all familiar with the present depression in railroad and general business and the attendant desire and demand to curtail expenditures in every possible direction to strengthen the existing financial situation with the prime motive of developing greater economy and efficiency in operation.
>
> 2. In the opinion of men of mature judgment in the manufacturing as well as the railroad fields we are confronted today with the serious situation of not knowing with any degree of certainty as to just when business conditions will improve. Many manufacturing concerns engaged in the production of railroad devices and specialties are either shut down or running at an unusually low rate of operation.
>
> While we realize this action is drastic, we feel that present conditions demand it. We are confident, however, that it will meet with the full approval of the business interests of the country, and we further believe that the future will warrant our resuming plans at a later date for the 1922 exhibit as in former years.

The executive committee also decided that it would not be necessary, in view of the cancellation of the exhibit and the annual meeting, to send representatives to such meetings of the Railroad, Mechanical and Purchases and Stores divisions, A. R. A., as may be held. The wisdom of cancelling hotel reservations was also suggested.

Mechanical Division of A. R. A. to Meet in Chicago

The General Committee of the Mechanical Division of the American Railway Association at a meeting in New York on March 30 decided to hold a business session at the Hotel Drake, Chicago, on June 15 and 16 instead of the convention that was to have occurred at Atlantic City. The program has been modified and reports will be presented only by the committees on the following subjects: Prices for Labor and Material, Car Construction, Loading Rules, Brake Shoe and Brake Beam Equipment, Train Brake and Signal Equipment, Specifications and Tests for Materials, Tank Cars and Standard Methods of Packing Journal Boxes. Both morning and afternoon sessions will be held while the division is meeting.

Locomotives to Be Built in Poland

It is stated by the Warsaw correspondent of the London Times that with the object of encouraging home industries the Polish government has recently signed contracts with a number of manufacturers in Poland for the delivery of large quantities of rolling stock for the Polish railways within the next 10 years. The firms chiefly concerned are the Polish Locomotive Works, Sosnowice, which has received an order for 1,100 locomotives; Lilpop, Rau & Lowenstein, Warsaw, which has received an order for 1,000 locomotives, 20,000 freight cars and 3,000 passenger cars; and the Ostrow Wagon Works, which has received an order for 18,000 freight cars and 2,800 passenger cars. None of these firms are in a position to carry out these orders with their present plants. The Polish Locomotive Works does not at present build complete locomotives, although it manufactures locomotive boilers. Neither has the Lilpop, Rau & Lowenstein plant built locomotives previously. The Ostrow Works is an entirely new enterprise and its factory is still in course of construction. Obviously these firms will need foreign capital and machinery to enable them to complete their orders.

Charges of Shop Unions Renewed

Five additional organizations of shop employees and the Railway Employees Department of the American Federation of Labor have joined with the International Association of Machinists in the complaint filed with the Interstate Commerce Commission requesting an investigation of railroad car and locomotive repair work. The original complaint was filed January 8, 1921, by W. Jett Lauck, representing William H. Johnston, president of the machinists. The press notice, just issued by way of keeping the subject alive, says that since the filing of the original complaint additional investigations have been made and the employees now claim to be prepared to fully substantiate all the charges made. The union heads who have joined with the Machinists' Association in the complaint, and the organizations which they represent, are as follows: B. M. Jewell, president of the Railway Employees Department, American Federation of Labor; J. J. Hynes, international president of the Amalgamated Sheet Metal Workers' International Alliance; Martin F. Ryan, general president of the Brotherhood of Railway Carmen of America; James P. Noonan, international president of the International Brotherhood of Electrical Workers; J. W. Kline, president of the International Brotherhood of Blacksmiths, Drop Forgers and Helpers of America; J. A. Franklin, president of the International Brotherhood of Boilermakers and Iron Shipbuilders.

Employee Educational Work on the Great Northern

To meet a desire expressed by a number of employees, particularly in the engineering department, for an opportunity to acquire a broader knowledge of railroading than comes to them through the routine work of their own departments, the Great Northern is developing a course of study to be taken up at bi-monthly meetings, in St. Paul, of a class of several hundred employees. The course is designed to cover a period of about six months and the class is open to employees of all departments who are interested.

The extent of the interest is indicated by the fact that over 400 employees responded to the call for the first meeting. Interest in the plan is also developing among employees at outlying points and consideration is being given to means of extending it. This work had its inception among employees and officers at the headquarters of the road at St. Paul. Consideration is also being given to the development of a course of study that will meet the special requirements of interested employees in the mechanical department.

Retrenchment

Further extensive reductions of forces by the Pennsylvania Railroad were reported on February 26, at Altoona, Pittsburgh and other points. The operation of the Pittsburgh Terminal as a separate division is to be discontinued and the old division boundaries will, in general, be restored.

The Delaware, Lackawanna & Western has ordered further reductions in forces at the Scranton shops. The Union Pacific on February 26 ordered further extensive reductions in its shops. On the New York Central, large numbers of men returned to work in the shops at Collinwood, Ohio; Elkhart, Ind., and other points, after forced vacations of one or more weeks.

The Canadian National, following the severe falling off in business throughout large sections of Canada, has taken off some passenger trains in New Brunswick, including trains No. 31 and No. 32 between Moncton and Levis. In the western part of Ontario considerable numbers of men have been dismissed and two divisions have been consolidated into one.

Two hundred men in the shops of the New York, Ontario & Western at Middletown, N. Y., resumed work on March 1 after a layoff of a month.

Freight Cars

The Louisiana & Arkansas has ordered 25 Hart convertible dump cars from the American Car & Foundry Co.

The Tientsin-Pukow has ordered 300 40-ton all-steel gondola cars through Mitsui & Co., 65 Broadway, New York, from the American Car & Foundry Co.

Locomotives

The Imperial Japanese Government Railways is having 30 locomotives built in Japan.

The Peking-Hankow has ordered 30 Prairie type locomotives from the Baldwin Locomotive Works.

The Louisville & Nashville will build 34 locomotives, including 16 Mikado type locomotives, in its own shops.

Shop Construction

Live Oak, Perry & Gulf.—This company has begun the reconstruction of its blacksmith and car shops at Live Oak, Fla. The buildings will be of frame construction, 50 ft. by 60 ft. and 60 ft. by 150 ft., respectively. The following new machinery will be purchased: planer, shaper, drill press and wheel press.

Louisville & Nashville.—This company has awarded a contract to H. W. Hancock, Louisville, Ky., for the construction of a roundhouse and shops at Loyall, Ky., at an approximate cost of $150,000.

Ann Arbor.—This company will replace its woodworking shop at Owosso, Mich., recently destroyed by fire, with a steel fabricated building.

Northwestern Pacific.—This company will erect temporary structures to replace the machine shop, wood working mill, car repair shop and minor buildings which were destroyed by fire at

Tiburon, Cal., as definite decision has not been made as to whether a modern shop will be constructed at that point, or some more advantageous location along the line.

Atchison, Topeka & Santa Fe.—This company has authorized the construction of a blacksmith shop at San Bernardino, Cal., with dimensions of 80 ft. by 306 ft., to cost $107,000. The company will also build a lavatory building at Needles, Cal., to cost $22,500.

MEETINGS AND CONVENTIONS

The American Railway Tool Foremen's Association will hold its eleventh annual convention at the Hotel Sherman, Chicago, on August 9, 10 and 11.

The American Society for Steel Treating will hold its 1921 convention and exhibition at Indianapolis, Ind., on September 19 to 24 inclusive. The exhibition will be in the Manufacturers' building at the State Fair Grounds which will provide a floor space of 76,800 sq. ft., and the meetings will be held at the Women's building, which is located a short distance from the exhibition hall, where three or four large rooms will make it possible to hold sectional meetings simultaneously.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City. Annual convention May 3 to 6 inclusive, Hotel Sherman, Chicago.

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Next meeting June 15 and 16, Hotel Drake, Chicago, Ill.

Division V—Equipment Painting Division.—V. R. Hawthorne, Chicago.

American Railway Association, Division VI—Furchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio. Second annual meeting June 20-22, Atlantic City, N. J.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamlin Ave., Chicago. Convention September 12-14, Hotel Sherman, Chicago.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago. Convention August 9, 10 and 11, Hotel Sherman, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Societv of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Spring meeting May 23 to 26 inclusive, Congress Hotel, Chicago.

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention September 19-24, Indianapolis, Ind.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Next meeting April 12. A paper on Some Side Light on Railway Time Tables will be presented by A. Hatton, general superintendent transportation, Canadian Pacific, Montreal.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Fine Ave., Chicago. Meeting second Monday in month, except June, July and August, New Morrison Hotel, Chicago.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

Central Railway Club.—H. D. Vought, 95 Liberty St., New York.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill.

Cincinnati Railway Club.—W. C. Cooder, Union Centrat Building, Cincinnati, Ohio. Meeting second Tuesday of February, May, September and November, Hotel Sinton, Cincinnati, Ohio.

Dixie Air Brake Club.—E. F. O'Connor, 10 West Grace St., Richmond, Va.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 715 Clarke Ave., Detroit, Mich. Next meeting August 16, 17 and 18, 1921, Hotel Sherman, Chicago.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago. Next annual meeting, May 24-26, 1921, Hotel Sherman, Chicago.

International Railway General Foremen's Association.—William Halt, 1061 W. Wabasha Ave., Winona, Minn. Convention, September 12, 13, 14 and 15, 1921, Hotel Sherman, Chicago.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York. Convention, May 23 to 26, 1921, inclusive, Flanters' Hotel, St. Louis, Mo.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting April 12. Paper on Freight Claims—Their Cause and Prevention, will be presented by Charles M. MacDonald, freight claim agent, Boston & Maine.

New York Railroad Club.—H. D. Vought, 95 Liberty St., New York.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Meeting second Thursday in month, alternately in San Francisco and Oakland, Cal.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Meetings fourth Thursday in month except June, July and August, Americus Club House, Pittsburgh.

St. Louis Railway Club.—B. W. Frauenthal Union Station, St. Louis, Mo. Meetings second Friday in month, except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Buffalo, N. Y.

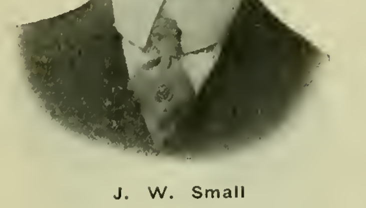
Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Meeting third Monday each month except June, July and August.

PERSONAL MENTION

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

F. G. Fischer

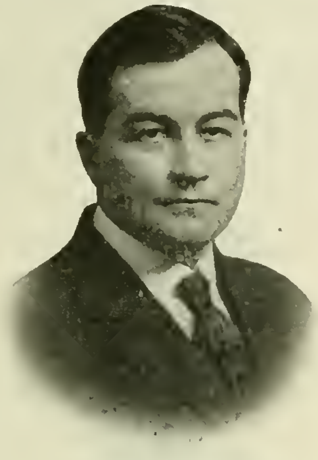
Frank G. Fischer, whose appointment as master mechanic on the Southern division of the St. Louis-San Francisco at Memphis, Tenn., was announced in the March issue of the *Railway Mechanical Engineer*, was born on October 19, 1878, at Richmond, Va. He received a common school education and entered the employ of the Chesapeake & Ohio on February 1, 1895, as a machinist apprentice. After working at various places on the Chesapeake & Ohio and the Baltimore & Ohio Southwestern as a machinist and roundhouse foreman until July, 1903, Mr. Fischer was employed in the roundhouse of the St. Louis-San Francisco at St. Louis, Mo. He then served successively as general foreman at Chaffee, Mo.; general foreman at Memphis; general foreman at St. Louis, and until his recent appointment was assistant master mechanic at Monett, Mo.



J. W. Small

J. W. Small, formerly superintendent of motive power of the Seaboard Air Line, has been appointed superintendent of motive power and shops of the Cuba Railroad with headquarters at Camaguey, Cuba, succeeding M. B. McPartland, resigned to accept service with another company. Mr. Small was born on September 24, 1870, at Chatham, Ont., and was educated in the high schools of that city and at the Collegiate Institute. He entered railway service in 1887 as a machinist apprentice on the Northern Pacific. In 1892 he went to Pocatello, Idaho, as a machinist on the Oregon Short Line. The following year he went to Tacoma, Wash., as a machinist for the Northern Pacific. During the same year he entered the service of the Southern Pacific as a machinist and served subsequently as gang foreman, roundhouse foreman, assistant master mechanic and master mechanic for that company. In 1906 he became superintendent of motive power of the Mexican lines of the Southern Pacific. In 1910 he went to the Kansas City Southern in a similar capacity and the following year became superintendent of motive power for the Missouri Pacific. The same year he went with the Sunset Central Lines (Galveston, Harrisburg & San Antonio, Houston & Texas Central, Morgan's Louisiana & Texas, Texas & New Orleans, etc.) as assistant general manager. In 1913 he was appointed superintendent of motive power of the Seaboard Air Line. During federal control Mr. Small served first as mechanical assistant to the regional director, Southern region, and later as mechanical staff officer to the regional director of the same region.

Harry M. Allan, whose appointment as master mechanic on the Canadian Pacific with headquarters at Kenora, Ont., was announced in the March issue of the *Railway Mechanical Engineer*, was born on July 26, 1886, at Balderson, Ont., and attended the Balderson public schools and the Perth high school. In October, 1906, after serving his apprenticeship with the Canadian Atlantic at Ottawa, Mr. Allan entered the employ of the Algoma Central at Sault Ste. Marie, Ont., and in March, 1907, resigned, and went from Fort William to Winnipeg and on to Moose Jaw, Sask., where he worked as a machinist for the Canadian Pacific. In 1910, he was promoted to shop foreman and from 1913 until his appointment as mentioned above, he was locomotive foreman in the Alyth roundhouse at Calgary, Alta.


H. M. Allan

CAR DEPARTMENT

Andy J. Litwin, car foreman on the Northern Pacific at Paradise, Mont., has been transferred to Staples, Minn., succeeding F. M. Weseman, deceased.

SHOP AND ENGINEHOUSE

W. Arthur Birch, freight gang foreman on the Atchison, Topeka & Santa Fe, at Needles, Cal., has been transferred to Barstow, Cal., to succeed E. O. Faulkner as roundhouse foreman.

H. D. Eddy, roundhouse foreman on the Atchison, Topeka & Santa Fe, at Needles, Cal., has been transferred to Bakersfield, Cal.

E. A. Murray, whose appointment as shop superintendent on the Chesapeake & Ohio, at Huntington, W. Va., was announced in the February issue of the *Railway Mechanical Engineer*, was born on September 1, 1876, at Staunton, Va. He received a public school education and on December 11, 1891, entered the employ of the Chesapeake & Ohio as a machinist apprentice. After completing his apprenticeship, he served successively as a machinist, locomotive fireman and gang foreman until 1903, when he was appointed general foreman. From 1909, until his recent promotion as above noted, Mr. Murray was master mechanic at Clifton Forge, Va.


E. A. Murray

George F. Heise has been promoted to the position of toolroom foreman of the El Paso & Southwestern shops at El Paso, Tex.

PURCHASING AND STOREKEEPING

J. E. Wharton, division storekeeper on the Pennsylvania, with headquarters at Toledo, Ohio, has been appointed storekeeper, maintenance of equipment department, with the same headquarters. The position of division storekeeper has been abolished.

SUPPLY TRADE NOTES

The R. G. Smith Tool & Mfg. Co. has moved from 315 Market street, into their larger factory at 245 N. J. R. R. avenue, Newark, N. J.

The H. K. Ferguson Company, southern department, has removed its offices to Room 218, Healey building, Atlanta, Ga. Richard W. Alger is the manager.

The Independent Pneumatic Tool Company, Chicago, has removed its Pittsburgh, Pa., office from 1208 Farmers Bank building, to 718 Bessemer building, corner of Fort and Duquesne Way.

Manning, Maxwell & Moore, Inc., New York, on May 1, will take over the merchandise and good-will of Patterson, Gottfried & Hunter, 211 Center street, New York. This firm handles mill and factory supplies.

Carl W. Bettcher has been appointed sales manager of the Eastern Machine Screw Corporation, New Haven, Conn. Mr. Bettcher was born on May 7, 1887, and graduated from the Boardman Manual Training School in 1904. He is also a graduate of Yale University, having completed the Sheffield Scientific course in 1907. The following two years he spent on the students' course at the General Electric Company at Lynn, Mass., doing principally testing work. He then entered the sales department of the Edison Lamp Works at Harrison, N. J., and after eight years of service with this company, became a captain of artillery in the United States Army and, for nine months of two years, was in active service in France. For the past two years he has been in the employ of the Eastern Machine Screw Corporation and will now specialize principally in the expansion of the sale of the H. & G. self-opening die heads.


Carl W. Bettcher

H. M. Pratt, manager of the branch office of the Southern Iron and Equipment Company at New Orleans, La., has been appointed general sales manager with headquarters at Atlanta, Ga. A. C. Wood succeeds Mr. Pratt at New Orleans.

The O'Malley-Beare Valve Company of Chicago has been appointed exclusive agent for the Chapman Valve Manufacturing Company of Indian Orchard, Mass., and will have charge of the sale of the Chapman lines of valves in the railway field in the United States.

The Southwark Foundry & Machine Company, Philadelphia, Pa., has opened a district office at 804 Swetland building, Cleveland, Ohio, under the management of its representative, Stewart Bolling, who has served for seven years as engineering salesman for this company.

The National Malleable Castings Company, Cleveland, Ohio, has bought the draft gear business, assets and good-will of the Butler Drawbar Attachment Company, Cleveland. The business of the latter company has been transacted for many years through the National Malleable Castings Company.

Harry L. Oviatt has been appointed traveling representative of the Armstrong Manufacturing Company, Bridgeport, Conn., manufacturers of pipe threading tools and taps. Mr. Oviatt has been with the Bullard Machine Tool Company, Bridgeport, for the past 13 years and during the last 3 years has been connected with the advertising department.

The Commonwealth Steel Company, St. Louis, Mo., has recently established an employees' benefit association, which provides insurance against sickness, accident or death for the employees. The company has offered to each member of its force a life insurance policy, varying in amounts from $500 to $2,000, depending on the length of service.

William C. Wilson, formerly connected with the Taylor-Wharton Iron & Steel Company and William Wharton, Jr., Company, in the capacity of manager of sales, northeastern territory, has become associated with the Pittsburgh Screw & Bolt Company, Pittsburgh, Pa. He will be located at its New York Office, 50 East Forty-second street.

The Power Equipment Company, 131 State street, Boston, Mass., has been appointed New England representative of the Conveyors Corporation of America, Chicago, for the sale of its American trolley carrier monorail conveying equipment, and Colwell & McMullin, 79 Milk street, Boston, are the New England representatives for its American steam ash conveyor.

The American Mason Safety Tread Company, 480 Lexington avenue, New York, has consolidated its general sales office for the New England States, New York State and New Jersey with the local New York City office, under the supervision of J. W. Scott. L. H. Devoe will continue to serve the trade in this territory as in the past, with headquarters at New York.

W. J. Roehl, formerly assistant purchasing agent of the Missouri Pacific, has been appointed sales representative in the St. Louis district for A. M. Castle & Co., Chicago, and has opened offices at 1946 Railway Exchange building, St. Louis. Mr. Roehl entered railroad business on May 4, 1906, as a clerk in the office of the supply agent of the Missouri Pacific and in May, 1910, was promoted to chief clerk. On March 1, 1913, he was promoted to chief clerk to the general purchasing agent and on June 1, 1918, became assistant purchasing agent.


W. J. Roehl

A. M. Castle & Co., in addition to their warehouse business in Chicago, are general distributors for the Rome Iron Mills' staybolt iron, the Lukens Steel Company's locomotive, flange and fire box steel; and the Detroit Seamless Steel Tubes Company's locomotive seamless boiler tubes.

The Liberty Car & Equipment Company and the Illinois Car & Manufacturing Company, both of Hammond, Ind., have been consolidated under the name of the Illinois Car & Manufacturing Company, with general offices at Hammond, Ind. The officers of the consolidated company are: P. H. Joyce, president; J. W. O'Leary, vice-president; J. F. Farrell, vice-president; J. E. Fitzgerald, treasurer, and O. R. Shearman, secretary. The plant at Chicago Heights is now known as the Liberty plant and the one at Hammond as the Hammond plant.

The Equitable Equipment Company, 411 Whitney Central building, New Orleans, La., has completed its organization for the purpose of handling locomotives, cars, railroad equipment, rails and rail accessories, machinery of all kinds, contractors' equipment and second hand machinery and equipment. This new company is taking over the equipment, rail and machinery business of A. Marx & Sons, Southern Scrap Material Company and the Ship Supply Company. The new firm will be under the direct management of O. D. Cleveland, who has been the manager of the New Orleans branch of the General Equipment Company.

Superheater Company

The election of three new vice-presidents is announced by the Superheater Company, New York, formerly the Locomotive Superheater Company. Gilbert E. Ryder, in charge of the service department, has been elected vice-president in charge of sales, with office at New York; Henry B. Oatley, chief engineer, has been elected vice-president in charge of engineering, with office at New York, and Charles H. True, works manager, has been elected vice-president in charge of production, with office at East Chicago, Ind.

Gilbert E. Ryder, vice-president in charge of sales, was born at Minneapolis, Minn., in 1880, and studied engineering at the University of Wisconsin, and also at the University of Illinois. His railroad experience began with an apprenticeship on the Chicago, Milwaukee & St. Paul, and included service as a journeyman in the mechanical department of that road at Dubuque, Ia.; Ottumwa, Ia., and West Milwaukee, covering five years. His engineering experience followed in the fuel testing bureau of the Technologic Branch of the United States Geological Survey. He later served the city of Chicago as deputy smoke inspector in charge of locomotives, which placed him again in contact with the locomotive fuel conservation problem. This was followed by editorship of the Railway Review at Chicago, after which he entered the service of the Superheater Company ten years ago. He became a member of the service department and later took charge of that department. He also developed and had charge of the publicity department. Mr. Ryder takes responsibility of the sales of the company (railroad, stationary and marine), with an unusual preparation in wide and very valuable engineering and practical experience.


G. E. Ryder

Henry B. Oatley, vice-president in charge of engineering, was born at Rochester, N. Y., and attended the public schools at that place. He received his engineering education at the University of Rochester and the University of Vermont, graduating from the latter in 1900 with the degree of mechanical engineer. He then entered the service of the Schenectady Locomotive Works, his experience while on this work embracing locomotive design and shop testing. He was associated with F. W. Cole in the early development of the superheater for locomotives by that company. In 1910, upon the formation of the superheater company, he was appointed mechanical engineer, and in 1916 he was appointed chief engineer for the company, which position he held at the time of his election, as above noted. In April, 1917, he was granted a leave of absence and served as an officer in the U. S. Navy on the battleships Ohio and Indiana. He entered service with the 1st N. Y. Naval Militia, which was the first body of armed troops to move after the declaration of war with Germany. Mr. Oatley is a recognized authority on superheating and has been an active factor in its development. He is, in a large measure, responsible for putting superheater design upon a practical


H. B. Oatley

operating and manufacturing basis in locomotive, marine and stationary practice, and, without sacrifice of efficiency, has developed uniformity of sizes and design.

Charles H. True, vice-president in charge of production, was born in Boston, Mass., and was educated at the public schools of Schuyler, Neb., and the University of Nebraska, graduating in 1898 with the degree of electrical engineer. Immediately upon graduation he entered the service of the Union Pacific at Omaha, and served in both the locomotive and car shops. In 1902 he became roundhouse foreman at Grand Island, Neb., and in 1903 resigned from the Union Pacific to take a similar position at Trenton, Mo., with the Chicago, Rock Island & Pacific. In October of the same year he was transferred to the Silvis shops as assistant superintendent of shops. In 1905 he was appointed mechanical engineer with the Railway Materials Company, at Chicago, and was engaged in the design of metallurgical furnaces for blacksmith shops and boiler shops, and in 1910 he refitted and took charge of the Phoenixville, Pa., plant of this company. Two years later Mr. True resigned his position with the Railway Materials Company to become works manager of the Superheater Company at East Chicago, which position he held until his election as vice-president, as above noted.


C. H. True

The Richmond, Va., office of the Vapor Car Heating Company, Inc., has been discontinued and all future business from the Southeastern territory will be handled from the offices of the company in Washington, D. C. The Washington office is in charge of Harry F. Lowman, who is assisted by L. B. Rhodes, Jr., previously connected with the sales department of the U. S. Light & Signal Corp. Mr. Rhodes, Jr., has been assigned to the Southeastern territory formerly handled by his father, L. B. Rhodes.

J. Brookes Spencer, assistant to first vice-president of the Southern Wheel Company, St. Louis, Mo., has been elected vice-president of the same company with headquarters at St. Louis. Mr. Spencer was born in St. Louis on January 15, 1888. He was educated at the Hill School, Pottstown, Pa., and was graduated from Yale University in the class of 1910. In 1917 he entered the service of the Southern Wheel Company at St. Louis and has been with the company since that time with the exception of a year when he served in the United States Army.

Keith J. Evans, advertising manager Joseph T. Ryerson & Son, was elected president of the Engineering Advertisers' Association at the annual meeting at Chicago on March 8. Mr. Evans has been with the Ryerson company for eight years, all of that time in the advertising department. Just prior to the entry of the United States in the war, Mr. Evans co-operated with Donald Ryerson, vice-president of the Ryerson company, who organized the "Four Minute Men" as a lobby in favor of military training. When war was declared, the organization was turned over to the Government and became a division of the Committee on Public Information. Mr. Evans was appointed national business manager, with headquarters at Washington, D. C., and served in that capacity until the organization was well under way, when he entered the army, becoming a second lieutenant in the field artillery. As advertising manager of the Ryerson company, Mr. Evans originated the 450-page loose leaf Ryerson steel service book, a very complete and handy current data book covering specifications and prices.

TRADE PUBLICATIONS

Gas Producer.—"The Automatic Gas Producer" is the title of a 10-page booklet, illustrating and describing the construction and operation of automatic gas producers made by R. D. Wood & Co., Philadelphia, Pa.

Cupola Users.—The Whiting Corporation, Harvey, Ill., has issued Bulletin No. 155, being a list of cupola users, arranged geographically and alphabetically under the various sizes of cupola. This bulletin supersedes No. 152.

Filters.—A 7-page bulletin, descriptive of the G-R multiscreen filter, has been issued by the Griscom-Russell Company, New York. This filter is a redesign of the well-known Reilly multiscreen feed water filter and grease extractor.

Machine Tools.—George Swift & Sons, Halifax, England, have issued a general catalogue of machine tools, illustrating and describing the line of radial drills, lathes, slotters, shapers and planers which are included in the regular line manufactured by this company.

Pneumatic Tools.—Circular No. 41, representing the latest achievements in the development of the pneumatic tool industry has been issued recently by the Keller Pneumatic Tool Company, Grand Haven, Mich. Specifications and a list of Keller made products are included.

Iron and Steel Workers' Machinery.—A representative type of each of the tools manufactured by the Scully Steel & Iron Company, Chicago, is shown in a 128-page catalogue which they have recently issued. A few details as to the size and capacity of each machine are given.

Dust Collecting and Conveying.—Two 4-page bulletins, Nos. 12 and 501, have been issued recently by the Dust Recovering & Conveying Co., Cleveland, Ohio. These bulletins illustrate and describe the development of dust collecting equipment and pneumatic conveying respectively.

Portable Electrical Drills and Grinders.—The Cincinnati Electrical Tool Company, Cincinnati, Ohio, have recently issued a new catalogue covering their complete line of portable electrical drills, grinders and buffers, including several new type machines which they have recently brought out.

Tap Drill Sizes.—A table of tap drill sizes for S.A.E. or A.S.M.E. machine tool standards has been prepared in pocket form by the Greenfield Tap & Die Corporation, Greenfield, Mass. Larger charts containing similar data and suitable for hanging in the shop for ready reference by the workmen, have also been brought out.

Sanitation and Welfare.—Bulletin No. 8 has been issued by the Bureau of Safety and Sanitation and Welfare of the United States Steel Corporation, New York, and contains 95, 8 in. by 10 in. pages devoted mostly to illustrations showing some of the things that have been done by the corporation and its subsidiary companies to improve the living and working conditions of employees.

Repair Parts.—The Roberts & Schaefer Company, Chicago, has prepared a book illustrating all of their modern equipment for coal, sand and cinder handling on locomotives. Each unit of each machine is numbered according to the reference kept in the office of the company, making it comparatively easy for one to order spare or repair parts for mechanical devices for coal, sand and cinder handling.

Tool Book.—The Goodell-Pratt Company, Greenfield, Mass., has recently issued tool book No. 14 containing 464 pages, 6 in. by 9 in. A detailed index of the fifteen hundred tools manufactured by this company is included in the front of the book, together with general information regarding design, making and inspection. List prices given in this catalogue were effective on January 1, 1920, and are subject to change without notice. For the convenience of mechanics and others who find the 6 in. by 9 in. book inconvenient to carry, a pocket edition with 3½ in. by 5½ in. pages is available.

Railway Mechanical Engineer

Volume 95 May, 1921 No. 5

CONTENTS

EDITORIALS:
- Simple Common Sense 273
- The Business Situation 273
- One Effect of Seniority Rules 274
- The Importance of Checking Cut-Offs 274
- The Future of the Steam Locomotive 274
- Notable Innovation in Freight Car Design 274
- An Old Friend 275
- Apprenticeship in France 275
- New Books 276

COMMUNICATIONS:
- Are American Roads Prejudiced Against Compounds? 276

GENERAL:
- Problems in Design and Operation of Large Locomotives 277
- Necessity for Improvement in the Design and Operation of Present Day Locomotives 282
- The Functions of Management 285
- Principles to Govern Agreements Defined by Labor Board 287
- The Advantages of the Exhaust Steam Injector 290
- The Rusting of Steel Containing Copper 291
- The Cost of Boiler Scale 292
- Comparison of Steam and Electric Locomotives 292

CAR DEPARTMENT:
- New Norfolk & Western 100-Ton Coal Cars 293
- Annual Report of the Bureau of Explosives 298
- Saving Money in Car Repairs 298
- Repair and Maintenance of Steel Freight Cars 299
- Draft Gear Tests of the Railroad Administration 301
- Car Inspectors Propose Change in Interchange Rules 304

SHOP PRACTICE:
- Uniform Heat Treatment of Steel 309
- Machining Driving Boxes 310
- Cast Iron Cutting 310
- Fuel Economy by Accurate Valve Setting 311
- Some Facts Regarding Bearings 312
- Paris-Orleans Apprentice Work Organized 313
- Four Efficient Santa Fe Machine Shop Devices 317
- Reaming Tube Sheet Holes 318
- A System of Progressive Shop Discipline 319
- Soft Packing Cutter 320

NEW DEVICES:
- Special Railroad Draw-Cut Shaper Attachments 321
- Cylinder Cock Closes When Engine Drifts 323
- Brake Shoe Key Taper Rolling Machine 323
- Improved Method of Crowning Pulleys 324
- Toothed Key and Sleeve Type Chuck 324
- Double Ball Bearing Hanger Boxes 325
- Heavy Duty Traverse Head Shaper 325
- Internal Micrometer of Unusual Design 326

GENERAL NEWS:
- Notes 327
- Meetings and Conventions 328
- Personal Mention 328
- Supply Trade Notes 330
- Trade Publications 332

Simple Common Sense

If the railroads are to give adequate service to the public which pays the bills, it will be absolutely necessary for the men and the managements to get together. Someone has said, "Figures don't lie, but liars figure." Some of the testimony recently introduced before the Railroad Labor Board is an insult to the intelligence of that Board and would seem to offer sufficient reason to adjudge those who gave it in contempt.

If the real reason for the long drawn-out and misleading exhibits which have been presented to the Board is to delay decisions on the part of the Board, then those who are giving the testimony should at least make a bluff at being in earnest and should talk to the point in controversy. As it is now the recent testimony of Lauck and Jewell is absurd and will react against the interests of the men these leaders are supposed to represent.

The wages of the shop crafts were increased to the present high standard for one reason only—to meet the highest cost of living recorded in recent years. We believe in paying good wages to railroad workers—wages that will enable the men to live well and that will attract the most desirable men to railroad service; but the cost of living has decreased considerably since wages were adjusted. We believe also in furnishing the public with a high grade of service at a reasonable cost, thus insuring the continued prosperity and development of the country and incidentally giving the men in railroad service steady employment. We believe also in giving the investors a fair return upon their money; if this is not done the large amount of capital necessary to improve the railroads will not be forthcoming, and incidentally the railroad employees will suffer because of business stagnation, since general business prosperity goes hand in hand with the prosperity of the railroads.

The interests of the employees, the managements, the public and the investors are so intimately associated and so dependent one upon the other, that they must work together, shoulder to shoulder, in the common interest. They must have a mutual understanding of each other's problems—this means a lot of educational work. Unless this co-operation can be brought about, sure disaster lies ahead. This is simple common sense.

The Business Situation

The latest report available as we go to press of the number of cars loaded with revenue freight is that for the week of April 16. There were 703,896 cars loaded, which is the largest number, with one exception, since the week of January 15, when 709,888 cars were loaded; the cars loaded for the week of March 5 totaled 712,822. Averaging the figures for the four weeks reported each month for the first quarter we find that the average weekly loading in January was 679,580, in February 683,088, and in March 698,627. In general coal loadings have fallen off, while merchandise, l. c. l. and miscellaneous loadings have steadily increased.

The indications are that the average weekly loading for April will be about the same as for March, although it may be larger. There are five weeks ending in April; the first week (April 2)—most of the days were in March—showed an abnormally low figure, 666,642, the lowest this year except for the week of January 1. If this first week is disregarded, April will undoubtedly make an excellent showing compared with the earlier months of the year. The average number of cars loaded with revenue freight for the first 15 weeks of 1921 was 687,296; this compares with 798,212 for the similar period in 1920 and 698,146 in 1919. Meanwhile the money market is easier and the prices of securities are higher than for some time. The car surplus has also shown a slight decline for the first time in months. Let us hope that the worst of the depression has passed!

One Effect of Seniority Rules

One apparently unfair and certainly costly result of seniority rules has come to our attention recently in their application to apprentices. An apprentice who had just completed a four-year course and developed into a valuable man for a certain railroad was outranked in point of seniority by a mechanic who had been employed but a short time before. The result was that when a reduction in forces was made at this point, according to the seniority rule, the apprentice was allowed to go and the mechanic was retained. Furthermore when it eventually becomes necessary to re-employ men the mechanic will have to be hired back again before the apprentice. This ruling certainly seems unfair from the standpoint of the apprentice and is a costly one to the railroad. There can be no question as to the relative value of a bright apprentice who has served four years with a railroad, becoming accustomed to its equipment and standards of operation, as compared to the value of a new mechanic who has just been employed. The latter in many cases simply calls himself a mechanic and has in reality had a limited experience.

The Importance of Checking Cut-Offs

An article on "Fuel Economy by Accurate Valve Setting" in this issue points out the possibilities of saving coal by setting locomotive valves more carefully, particularly as relates to equalizing and squaring the cut-offs. There are three common methods of squaring valves on locomotives with outside valve gears, of which the first and simplest is to equalize the valve travels. In this method the crank arms are set approximately correctly by a gage and, with the portmarks scribed on the valve stems, the travels can be readily found by trailing the engine, adjustments being made to equalize them. The objection to this method is that no check is made of the important points of steam admission and cut-off. In the second and more common method the engine is put on rolls and the leads, or port openings at the dead centers, checked, being squared in the full gear. This method is the one more commonly used and gives reasonably satisfactory results, the main objection to it being that no attention is paid to points of cut-off. It is no more necessary that steam ports open at the same instant than that they stay open the same length of time. In fact, from the standpoint of fuel economy, the second consideration is the more important. The third method of squaring valves, therefore, takes into account the cut-offs and differs from the second method only in carrying it a step further. The reverse lever is "hooked up" to bring the cut-offs at about 25 per cent of the piston stroke and the engine is run over, measuring the piston travel at the points of cut-off. Adjustments are then made to equalize the cut-offs, front and back, right and left. It has been demonstrated that valve events do not occur in regular order and because the valves are square in the leads is no indication that they will be square in the cut-offs. It is explained in the article that unequal cut-offs cause fuel waste due to the fact that the locomotive must be operated with the reverse lever unnecessarily near the corner. This means a larger consumption of steam and consequently of coal as has been demonstrated not only theoretically but by practical tests as well. The possibilities and great need of fuel economy are such as to warrant the most careful attention to setting valves and especially as regards equalizing the cut-offs.

The Future of the Steam Locomotive

The papers to be presented before the Spring meeting of the American Society of Mechanical Engineers which are published in this issue are notable because they represent an attempt to outline in a comprehensive way the direction that future progess will, or should, take. When an attempt is made to look forward it seems that the growth in motive power during the past 20 years has been easy because it was attained principally by increasing the size of individual engines. This statement should not be construed to mean that there have not been notable refinements in design during that period. The history of locomotive construction records occasional examples of extremely heavy power that were built prematurely and proved a total failure. These isolated instances show clearly that changes from the former practices were necessary before a satisfactory design of large locomotive could be evolved. There have been remarkable improvements in design during the last two decades, yet the principal development has been in increasing the size of the power.

It is doubtful whether development of the locomotive can proceed much further along these lines. The cylinders on heavy engines have now reached the clearance limits and the boiler is as high as it can be made. Although locomotives with six pairs of coupled wheels have been built in Europe, it would seem that the rigid wheel base of five coupled pairs of wheels is the maximum that can be operated over curves on the majority of roads in this country.

This does not mean that further progress in locomotive development must stop. If the limit of size has been reached, designers still have it in their power to make locomotives more efficient by refinement in design. In the past the majority of American roads have adhered to locomotives of the simplest possible types. Now there is need for more critical attention to the details of the machinery. It may be necessary to sacrifice simplicity and deliberately adopt features that will increase maintenance costs in order to reduce the fuel consumption of the engines and increase their capacity. The true measure of the efficiency of the mechanical department is not in the cost of repairs per locomotive or per car, but in the overall expense of fuel, wages and repairs for handling passengers and freight.

Notable Innovation In Freight Car Design

The common type of freight car truck, carrying the load on the center bearing, is one of the oldest features of car construction in general use, having been first applied in 1831. The very fact that this design has been perpetuated so long is conclusive evidence that it possesses merit. The flexibility of the structure is well suited for uneven track and the equalizing system minimizes the stresses that are transmitted to the car body. The clearance at the side bearings permits operation over tracks that are not in a true plane without imposing twisting stresses on the body and the small radius of the center bearing permits the truck to follow curves with little pressure on the wheel flanges.

Few designers have attempted to depart from the basic principles outlined above. Some trucks have been built which carry the load on the side bearings, but all have retained the transverse bolster as an essential feature. The new 100-ton coal cars of the Norfolk & Western described in this issue are noteworthy because of the fact that the load is carried on the side of the trucks and the center pin is used only to hold the truck in the proper position. By the use of longitudinal beams over the side frames the truck bolster is eliminated, being replaced by a light spider which holds the side frames square. This is especially noteworthy because six-wheel trucks usually require extremely heavy bolsters. The saving in weight by this method of supporting the load is not confined to the trucks. The body bolster likewise can be made lighter because instead of carrying the load to the center line, it is only necessary to carry it to the plane of the side frames, thus reducing the bending movement on this member materially.

Since the car is carried on four points of support, the question of the stresses set up when these points are not in the same plane becomes very important. The tests conducted on the first car built show that uneven track causes only slight variations in the load on each group of springs and does not result in excessive distortion of the car body.

Aside from the interest attached to the new design, the cars are notable for the high ratio of load to gross weight. Unnecessary dead weight in freight cars is costly to haul and light equipment offers opportunities for materially reducing operating expenses. The satisfactory performance of these cars since they were placed in service indicates that no unusual difficulties will be experienced in their operation or maintenance, and the results will fully justify the bold step which the mechanical department officers of the Norfolk & Western have taken in departing from conventional design.

An Old Friend

Probably the most familiar piece of machinery or equipment in railroad shops and roundhouses is the wheel lathe—familiar in many cases because the same old lathe has stood in the same place for so many years. Wheel lathes may be divided roughly into three groups, the first of which includes those not operated at all. Railroad men would probably be surprised to know the number of wheel lathes that simply occupy floor space (mostly in roundhouses) and never turn a tire. The second group includes wheel lathes which are operated but never ought to be. Perhaps they are underpowered and can hardly carry a one-quarter inch cut with one-eighth inch feed; sometimes their capacity is limited and large tires must be removed and turned on a boring mill, or shipped to another shop; in other cases the driving gears and mechanisms are so badly worn that the lathes cannot be operated even under medium cuts without seeming to tear themselves apart. The third group, to which fortunately a majority of wheel lathes belong, includes those modern productive machines which can, under average conditions, turn a pair of the largest tires in an hour or an hour and a half. Our point is that there are not enough machines of the third group in shops and roundhouses and that certainly there can be no excuse for longer retaining lathes in the first group.

It is said that the money for new wheel lathes is not available; also, that a roundhouse does not warrant the installation of a high priced special machine like a wheel lathe. Granting that in many cases the first statement is true and that the second holds for the smaller roundhouses, the only logical solution is to ship driving wheels to back shops where modern, productive wheel lathes are installed. Taking into account transportation charges and other elements, the tires will be turned quicker, better and cheaper. The examples of inefficient, worn-out wheel lathes are too numerous to mention and the only suitable place for obsolete and inefficient machines is the scrap heap.

New axle lathes also are needed badly in both roundhouses and repair shops. A great deal of credit is due to roundhouse and shop foremen for their ingenuity and determination in accomplishing results with inadequate equipment. At the same time the methods which they are sometimes compelled to use are very costly. The amount of waste effort on American railroads in a year due to the removal of tires for turning or pressing out axles to true up the journals is far too great. It is earnestly hoped in the present reorganization and attempt to place railroad finances on a firm basis once more that capital will be available to provide the shop machinery and equipment so badly needed for efficient, economical shop and roundhouse operation.

Apprenticeship in France

Elsewhere in this issue is an interesting article on apprenticeship as developed by the Paris-Orleans during the war. The principles which served as a basis for reorganizing apprentice courses are outlined in the article which explains the difficulties encountered and the results accomplished. The French have always realized the importance of training apprentices and workmen and in 1891 seven important railway systems had flourishing apprenticeship organizations. These systems differed in one essential. One group distributed the apprentices throughout the workshops and the other required their segregation in specially assigned buildings. These conditions continued from 1891 to 1900. On March 30, 1900, a law went into effect which forbade apprentices working in buildings where men were employed for more than ten hours a day. The effect of this law was practically to kill apprenticeship on some roads and to cause a notable falling off on others. At the beginning of the war, in spite of the high wages paid in ammunition factories and the consequent difficulty of securing apprentices, the Paris-Orleans reorganized its apprentice courses as explained in the article. Apprentice centers were formed in repair shops and roundhouses directly in opposition to the act of March 30, 1900, but the adoption of the eight-hour day in 1919 solved all difficulties in this connection.

The first principle of reorganization was recognized as the need for holding the interest of apprentices and paying them as much as possible by reducing the amount of unprofitable work to a minimum. The second principle developed was the importance of showing boys coming from a primary school just how and why practical work is done, as explained. An apprentice placed singly in a gang of workmen follows bad examples more quickly than good ones and in order that good habits of practice, discipline and self-reliance should be acquired, it was found best to group apprentices under the direction of capable instructors. One of the particular difficulties encountered was in the selection and training of these instructors. It was fairly easy to obtain good, practical workmen but they did not always have the mental requirements necessary for teachers. The recruiting of theoretical instructors also presented difficulties, perhaps the greatest trouble being to find instructors who would not confine themselves too closely to theoretical instructions difficult for the pupils to assimilate. The general conclusion seems to be that the quality and quantity of work performed by apprentices in the third year at least offsets their under-production in the first year and that the improvement of facilities for recruiting and developing capable shop employees and foremen is a clear profit.

It is interesting to note that apprenticeship centers are maintained at important roundhouses in France to afford preliminary training for engine drivers. In this way a man becomes a mechanic before he is a fireman or engine driver and the result is that most French enginemen are of mature years, thoroughly familiar with the detailed construction of practically all locomotive parts and are therefore able to give them the most intelligent and careful attention. French railroad men as a whole were astounded at the comparative youth of Americans assigned to drive the heavy American

Consolidation locomotives sent to France with the A. E. F. While these locomotives hauled an immense amount of traffic without serious accident, the American engine drivers could undoubtedly have taken lessons from their older French brothers in fuel economy and getting mileage between shoppings.

NEW BOOKS

Cams, Elementary and Advanced. By Frank De Ronde Furman. 224 pages, 6 in. by 9 in., bound in cloth. Published by John Wiley & Sons, Inc., New York City.

The chief original features of this book include the development and use of logarithmic, cube, circular, tangential and involute base curves, the establishing of cam factors and the demonstration that the logarithmic base curve gives the smallest possible cam for given data. The material given includes also the comparisons of the characteristic results obtained from all base curves in which the relative size of each cam, and the relative velocity and acceleration produced by each, is shown graphically in one combined group of illustrations. This enables the designer to glance over the entire field of theoretical cam design and quickly select the type that is best adapted for the work in hand. From these diagrams it is possible to note which form of cam is best adapted for gravity, spring or positive return, which is best for fast or slow velocities at various points in the stroke and which ones are apt to develop "hard spots" in running. Cam constructions best suited for heavy work in one or both directions are also described. All of the material is fully and clearly presented, the processes of design being mostly graphical and readily followed by practical shop men and draftsmen as well as by technical students.

Simple Superheated Steam Locomotives (Heissdampf Lokomotiven mit Einfacher Dehnung des Dampfes). By Eugene Brückmann. 600 pages, 11 plates, 7½ in. by 10½ in., illustrated. Bound in cloth. Published by C. W. Kreidel, Berlin, W. 9, Germany.

This volume is the third edition of a book which forms part of a cyclopedia on railroad practice. Being restricted to the most important type of motive power in use today, it covers the field comprehensively, treating the subject historically as well as on the basis of present practice.

The book opens with a history of superheated steam locomotives and describes many old patents as well as notable constructions of more recent date. A short chapter is devoted to the qualities of superheated steam, and this is followed by an analysis of the possible saving in water and fuel by the application of superheat. The increase of tractive effort at the drawbar and at the tender is analyzed for various pressures, for high and low speeds, compared with dry steam and with steam containing 20 per cent water. The limitations of steam pressure and superheat are also discussed.

The chapters on the locomotive boiler discuss the production of superheated steam, combustion in the locomotive and the theory of the locomotive boiler and superheater. The general discussion is followed by the computation of a saturated and a superheated steam boiler for the comparison of their performance and capacity. Rules for the calculation of boilers are given and materials for the construction of superheaters are discussed. The section on the types of construction and development of superheaters is very complete. A chapter is devoted to the calculation of the details of machinery for superheated locomotives which is followed by a discussion of the development of the superheated steam locomotive, instructions for handling locomotives in service, and descriptions of some of the newest types constructed. Tabulations of dimensions and drawings showing the general design complete the volume.

COMMUNICATIONS

Are American Roads Prejudiced Against Compounds?

Heath, Mass.

To the Editor:

It would be interesting to know the number of compound locomotives, exclusive of Mallets, still operated by railroads in this country and the results obtained. Many railroad men would no doubt feel that such information would be of no interest as the utility of compounds in the United States is definitely settled. Is this not largely a matter of prejudice? We read now and then of cross-compounds converted into superheated simple engines and of the economies effected, but why not retain the compound arrangement and add superheat as has been done successfully in Europe as well as in the case of American Mallets? Some statements regarding compound locomotives give the impression that intercepting valves are difficult to maintain. This argument does not appear sound for in the last decade devices have been added to the locomotive which require as much, if not more, attention than an intercepting valve.

An analogy in prejudice may be cited in marine engineering. Many of the latest ships will be found to be without superheaters and yet the idea of a marine engineer building a non-compound engine would be considered as absurd as building a large locomotive without a superheater.

In view of the success of Mallets in such cases, it is strange that economy cannot be effected by the use of compounds on divisions of a suitable nature.

W. G. Landon.

Right Kind of Foremen's Courses.—American business is finding it profitable to train plant foremen in the elements of good foremanship. Courses of instruction, conducted in the plants and designed to train foremen to cope with the problems that present themselves each working day, not only are developing better foremen, but are bringing returns in the form of increased morale, lower labor turnover, reduced costs and greater production.

The purpose of foremanship training, says an authority on the subject in *Forbes Magazine* (N. Y.), is to increase production and decrease costs. It is easily understood that those two things naturally follow when foremen are developed into real leaders and man handlers, thoroughly conversant and proficient in all phases of their jobs. A well organized course, therefore, will have these general functions:

1. To view the foremanship job in the perspective.
2. To analyze its responsibilities.
3. To develop intelligent performance of these responsibilities.
4. To develop team work.
5. To develop correct interpretation of policies.
6. To develop constructive thinking.
7. To develop analytical ability.
8. To develop leadership and subordinate driving methods.

The course itself, he adds, must be planned specifically around the first four items. The rest is more or less the general result of the discussions and follow up. Any foremanship course that performs these functions, even to a limited degree, is serving its purpose.

Locomotive Building in France.—The French output of locomotives at the end of the year 1922 will be 1,300 per annum. As its normal home consumption will not be more than 600, France will, states the Times (London) Commercial Supplement, become an important rival in foreign countries.

Problems in Design and Operation of Large Locomotives

Necessity for Improvement to Secure Maximum Service, Reduced Maintenance Costs and Increased Earning Power To Be Discussed at Railroad Section of A. S. M. E.

THE design and operation of large locomotives is the general subject which will be discussed at the railroad session of the Spring meeting of the American Society of Mechanical Engineers, to be held at the Congress Hotel, Chicago, May 26, 1921. Three papers, each covering a different phase of the question, are to be presented. The detailed design of large locomotives will be treated by M. H. Haig, mechanical engineer of the Atchison, Topeka & Santa Fe. H. W. Snyder, mechanical engineer of the Lima Locomotive Works, will have a paper on the Necessity for Improvement in the Design and Operation of Present Day Locomotives, while the need for the 2-10-2 and other heavy freight locomotives for road service will be discussed by A. F. Stuebing, managing editor of the *Railway Mechanical Engineer.* Abstracts of the papers by Mr. Haig and Mr. Snyder are given below. The third paper will be published in the June issue.

The Design of Large Locomotives

BY M. H. HAIG

Mechanical Engineer, Atchison, Topeka & Santa Fe

THE design of a large locomotive depends on the service to which it is to be assigned. The service varies with the weight of the train to be hauled and the number of cars in the train, and is affected by the topography of territory on which it is to operate, ruling grades in each direction, length of grades, average speed between terminals, method of dispatching, whether single or double track between terminals, etc. This information being available, it is a reasonably simple matter to determine upon the leading features of a locomotive to meet the requirements.

Restrictions and Limitations Imposed

For a locomotive to give practically 100 per cent service, its design and construction must not be restricted by personal opinion or by physical limitations of the road. If the weight needed for adhesion in starting a given train is restricted by an opinion that certain wheel loads should not be exceeded or because bridges and track are not capable of carrying the necessary weight, then the capacity of the locomotive is restricted and the train must be adjusted to the locomotive, instead of the locomotive being built to suit the train. This in turn has a tendency to limit a division or a railroad as a whole. Limitations such as these, together with clearances of bridges and structures, obstructions along the right of way, etc., affect the locomotive design and construction. The locomotive as a whole is dwarfed, or some of its vital or essential parts are so dwarfed as to cripple the machine as a whole.

A railroad is a plant, establishment or organization for manufacturing transportation. The locomotive is a very important part of the plant and is one of the most direct earners of revenue from which the transportation-manufacturing plant obtains its income. As such, it is a matter of business and economical principle to adjust some of the physical conditions of the road to meet the requirements of the locomotive, to prevent dwarfing it and to prevent sacrificing its power. Meeting these requirements of the locomotive amounts to meeting the necessary requirements of traffic. No turntable installed at a principal roundhouse should be less than 100 ft. long, and in many cases the length should be 125 ft. The distance between the walls of a modern roundhouse should be great enough to permit closing the door behind the tender of a Santa Fe or Mikado type locomotive and have ample room for trucking between the locomotive pilot and the outer wall of the roundhouse. Passing tracks should be long enough to take trains justified by the business and traffic of the division or territory. Bridges, rail and roadbed should be capable of carrying a static wheel load of at least 65,000 lb. per pair and of permitting the additional stresses resulting from a freight speed of at least 45 miles per hour. In meeting the requirements of rail stresses particular attention should be given to the employment of heavy rails on curves.

Unless these physical conditions are provided, a locomotive cannot be designed and constructed without restriction and proper power cannot be furnished to meet requirements. The only governing factors should be the size of train and the traffic of the territory.

Leading Features of Locomotive Construction

Leading features of locomotive construction such as relative size of cylinders, length of stroke, total heating surface, superheating surface, grate area, etc., have been well covered by handbooks and pamphlets issued by locomotive builders and by reports to the various associations, as well as by articles in the technical press. Tables of principal dimensions of large locomotives are obtainable from the same sources, together with detailed descriptions of features of design and construction which have met with general favor and some which have been short-lived. A discussion or comment on these features would therefore be largely a repetition of facts already presented and easily available.

Features which have not been so generally discussed and exploited are those which keep a locomotive in service a maximum length of time, reduce engine failures to a minimum, reduce cost of maintenance and repairs, and increase revenue-earning power. Among these, durability of material and accessibility of parts are important factors. The latter implies arrangements by which a locomotive is made free from complications in construction, inexpensive to repair, easy to maintain, and so put together that needed repairs can be made handily and quickly.

Almost as important as providing a locomotive that will meet the requirements of trains to be hauled and traffic conditions, is providing one that requires minimum repairs—a locomotive that after one trip is ready to be turned for the next trip.

A locomotive is in revenue-earning service only when it is hauling trains. Any road can make a study and determine what proportion of its locomotives are unserviceable and what percentage of the time its serviceable locomotives are on the road. Such information will show what percentage of the time its engines are earning revenue.

To maintain the advantages of designs already existing and to develop these still further requires the unlimited co-operation not only of the mechanical, civil-engineering and operating forces of the railroads, but also of the locomotive builders, and particularly of the manufacturers of material.

The necessity for unlimited co-operation by manufacturers of material is evident from the study of failures of parts both large and small. On the principle of encouraging further consideration of such co-operation by all concerned and for the purpose of arousing interest in those details of locomotive construction which are not always given the attention to which they are entitled, a number of details which seldom appear among "leading dimensions" will be discussed.

Counterbalance

Important among such details and one which is affected particularly by designers and manufacturers of material, is the counterbalance. The blow from the counterbalance is caused by the difference between the weight of the revolving parts carried by the pins and the total weight in the wheel to balance both the revolving and reciprocating weights. In other words, it is the weight in the wheel to balance reciprocating weight that causes the hammer blow.

Weight of reciprocating parts therefore affects hammer blow of driving wheels, riding qualities of locomotives, possible damage to track and bridges and total weight of locomotive. It is particularly essential to make these parts as light as possible, and to make them light the material must be durable.

Due to the increase in weight of locomotives and to the hammer blow on rails when reciprocating parts are heavy, the 1915 Committee of the American Railway Master Mechanics' Association made the following recommendation:

> Keep total weight of reciprocating parts on each side of locomotive below $^1/_{100}$ part of total weight of locomotive in working order and then balance ½ weight of reciprocating parts.

An attempt to counterbalance large locomotives in both freight and passenger service according to this recommendation has demonstrated its merit, but has further demonstrated that the durability of both cast and forged steel must be improved if the method is to be continued.

Crossheads

The Laird type of crosshead is lighter than several other designs, its performance is very satisfactory in service, and it therefore has advantages in designing for light reciprocating parts. A crosshead of this type used interchangeably on large freight and passenger locomotives is shown in Fig. 1.

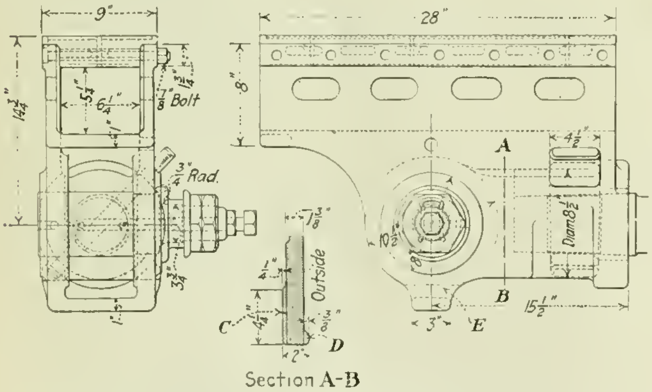


Fig. 1—Laird Crosshead Used on Various Types of Large Locomotives

The construction originally employed is shown by the figure, with the exception of later reinforcement at *C*, *D* and *E*. After about a year's service these crossheads began to break, the weakness appearing in the relatively thin wall between the hub around the piston rod and the lighter hub around the crosshead pin. The same weakness developed in crossheads of similar general design among locomotives of three or four different classes. The defects which proved common to these different crossheads are shown in Fig. 2.

By breaking up these crossheads in order to investigate the nature of the metal, it was found that in most cases each fracture had its origin in a shrinkage crack. The metal in most of the broken crossheads was found to be porous and to contain blowholes or gas holes, or shrinkage cracks, cold shuts or pipes. In some cases all of these defects were present.

Fig. 2 shows very clearly the difference in cross-section of the metal at and near the break. This difference is no doubt largely responsible for the defects in the metal which have caused an epidemic of failures. Crossheads of this general design have been used for many years, and as it appears impossible to modify the shape to advantage, the question, then, is whether foundries can adjust their practices to cast such irregular sections without blowholes, shrinkage cracks and other defects. This is one of the opportunities for manufacturers of material to co-operate with the locomotive designer.

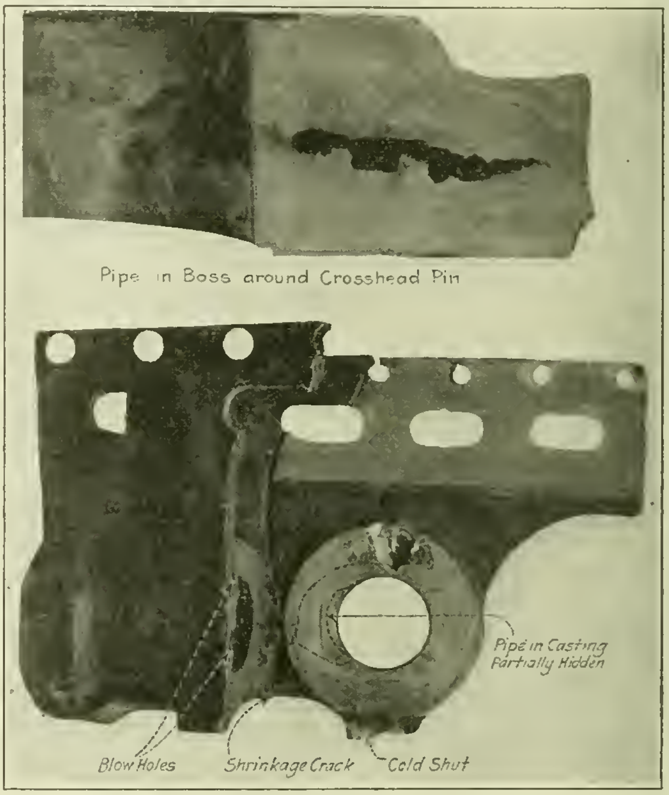


Fig. 2—Location and Nature of Defects in a Poorly Cast Crosshead

Driving Wheels

Another irregular section which causes shrinkage cracks is the cast-steel driving-wheel center. Rims and spokes are of much lighter section than the hub and counterbalance, and shrinkage cracks are not unusual at the juncture of these light and heavy sections. Foundries which cast locomotive parts have these conditions to meet and it is believed that foundry practices can be adjusted to meet them.

Crosshead Pins

In the development of locomotive construction within recent years the union link of outside valve gears has been connected direct to the crosshead pin. This reduces weight by eliminating the crosshead arm and by shortening the length of the combination lever, thus lessening reciprocating as well as total weight. A further advantage is in eliminating the bolted connection between the crosshead and arm.

In eliminating the crosshead arm the duty of the crosshead pin is increased. A broken crosshead pin is more serious than a broken crosshead arm. When a pin breaks there is a possibility of something else being broken and a very great probability of a cylinder head being knocked out and carrying a part of the cylinder wall with it. It is therefore absolutely necessary that the material in the crosshead pin shall be of a good quality, and the steel used should contain about 0.50 per cent carbon and have a tensile strength of 80,000 lb. per sq. in.

By reference to Fig. 1 it will be observed that the diameter of the union link shank of the crosshead pin is 3¾ in. This is believed to be considerably larger than usual in locomotive design. Even though the stresses in the crosshead pin are low, this large size appears to be a necessary precaution against the uncertainty in quality of material. As a further precaution there is a fillet of ¾-in. radius at the end of the shank.

Piston Rods

The greater number of breaks in piston rods of at least one railroad have been through the keyway. Next in order is the location in the crosshead fit adjacent to the collar. Breaks in the body are usually adjacent to the collar at the crosshead fit and occasionally at the collar adjacent to the piston-head fit.

The mechanical fit between the rod and the crosshead is often responsible for the breakage of the former. If there is not a good bearing throughout the length of the fit or at both ends of it, there is opportunity for a slight movement of the rod in the crosshead. This starts a crack which gradually progresses into a fracture. To facilitate making a good bearing at both ends of a piston-rod fit in a crosshead, the diameter is reduced 1/16 in. for a length a little greater than the keyway and about midway between ends of the fit. To prevent cracks starting in sharp corners at edges of the keyway, these edges are chamfered at both ends of the keyway and entirely around.

Rods with comparatively low stresses sometimes fail in such a manner that it is difficult to attribute a cause unless quality of material is responsible. This is true of rods of ordinary carbon steel as well as those of specially refined steel and of alloy steels. In this is another opportunity for the assistance and co-operation of manufacturers of material.

Cylinders

Failures of parts such as those described in preceding paragraphs, quality of material, uncertainty of cylinder cocks being operated, extreme variation in temperature due to use of superheated steam, foundry practices, etc., all affect the design of cylinders. Consideration of these and other features has resulted in the development of the design shown in Fig. 3, which is that of the cylinder of a Mikado locomotive. Except for modifications in dimensions this represents cylinders used also on Santa Fe, Mountain, Pacific and other locomotive types. The principal features of this cylinder are:

Simplicity in construction.

Uniform thickness of metal.

Absence of heavy metal sections at junctions of walls.

Walls and parts of ample thickness for strength, well ribbed, well braced and arranged with easy curves and generous fillets.

Uniform sectional area throughout length of steam and exhaust passages.

Short steam ports.

Small steam clearance.

Sections of metal, fillets and other features arranged to eliminate internal stresses set up in metal when cooling.

Double row of splice bolts holding halves of cylinder saddle together.

Double row of bolts at smoke arch.

Triple row of horizontal bolts securing cylinder casting to frame.

Depth of saddle casting directly above frame forming a box section and providing strength where shallow castings used with double-frame rail failed in the past.

Location of valve close to cylinder, permitting short ports, straight valve gear without offsets, and application of nearly straight steam pipe.

Large openings to cylinder cocks.

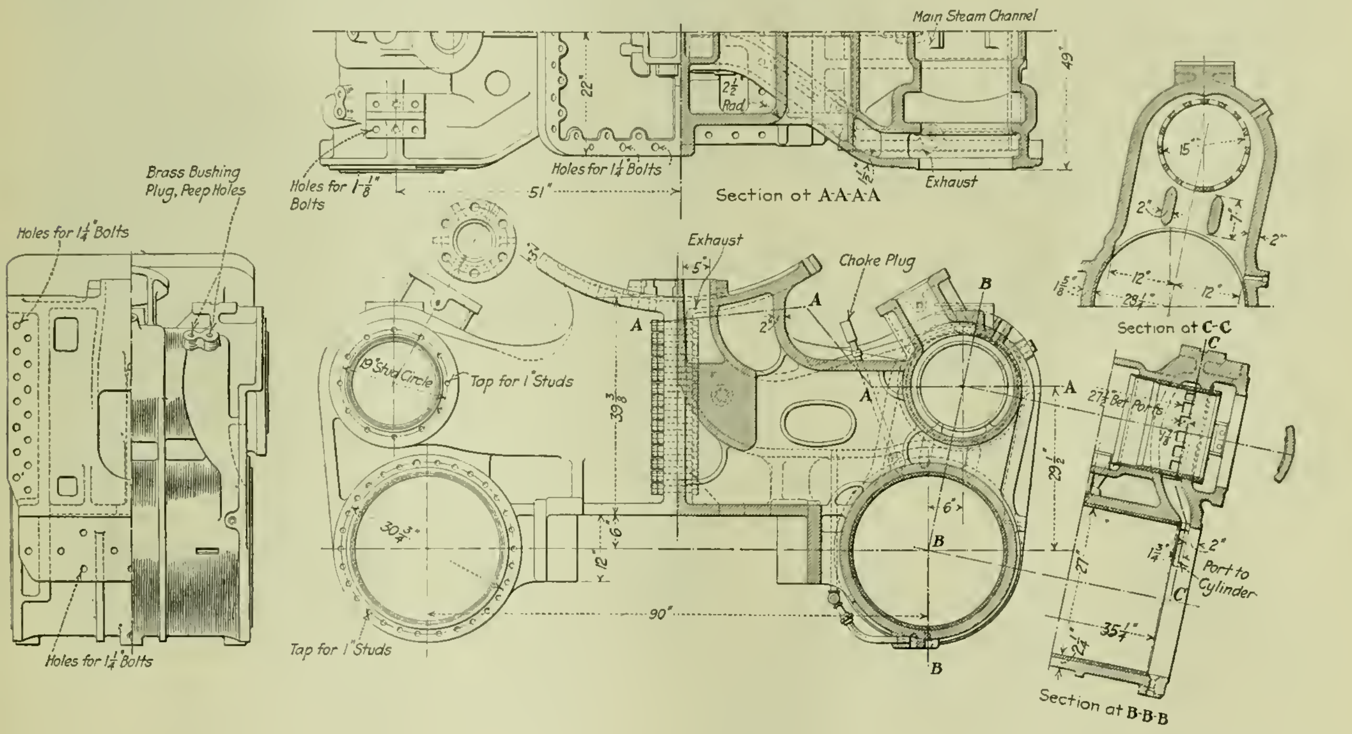


Fig. 3—Cylinder for Large Locomotive

The steam and exhaust channels are free from obstructions and restrictions which will interfere with free flow of steam. The exhaust channels are gradually reduced in area from valve bushing to base of exhaust pipe in such a manner that the cross-sectional area of any point in the channel is not larger than any area through which exhaust steam has previously passed.

A weakness in castings of some large cylinders has been in the wall around the live-steam port. As shown in Fig. 3, this wall is made 2 in. thick and the distance across the port below the valve bushing is 24 in. To reduce stresses in this wall it has been made thicker than most other walls of the casting and, compared with former practice, width across port has been reduced about 4 in. The bridges in the live-steam port are 2 in. thick. They were formerly but 1 in. in thickness and it was not unusual to find them cracked clear through. The change was made to increase the cross-section of the bridges in relation to the adjacent walls and thereby reduce tendency to shrinkage cracks.

To obtain a good cylinder casting from any design, it is necessary to have proper co-operation of the pattern shop and the foundry. Patterns must be well built and carefully checked. The checker should exercise especial care to see that patternmakers apply all the fillets called for. The foundry should so arrange the mold as to obtain uniform sections of metal. To insure this, careful measurements should be taken when cores are being set and a drop light should be let down into the mold when taking measurements.

Frame Braces

Locomotive frames are subjected to repeated lateral and twisting stresses, as well as to various other stresses, which will gradually break a single frame, but which can be withstood indefinitely by the application of substantial braces. An example of a pair of strong frames substantially braced is shown in Fig. 4, the arrangement illustrated being for a Santa Fe type locomotive. Bracing in the manner shown has been used for a number of years very successfully, and with very little modification is applicable to any locomotive class with outside valve gear.

Braces must be bolted to frames securely. Where braces or castings of other parts are bolted to a frame, the bolts should be applied with the head end bearing in these parts and not the thread end. This will provide for bearing on the bolt through the full thickness of the part bolted to the frame.

Boiler Cracks

In using the boiler to supplement the frames in forming a backbone or foundation from which to brace machinery parts, the boiler shell is subjected to additional stresses which result in cracks in the sheets. The most frequent causes of these cracks are guide-yoke braces, valve-motion braces and the ordinary belly braces to frames. Guide-yoke and valve-motion braces are often very stiff and are bolted securely to the frames and studded to the boiler. When the boiler expands the braces and connections are held rigidly by the frame and there is a tendency for the boiler to tear itself loose from these fastenings. This sets up strains in the metal which are aggravated by the vibration and pounding to which braces are subjected.

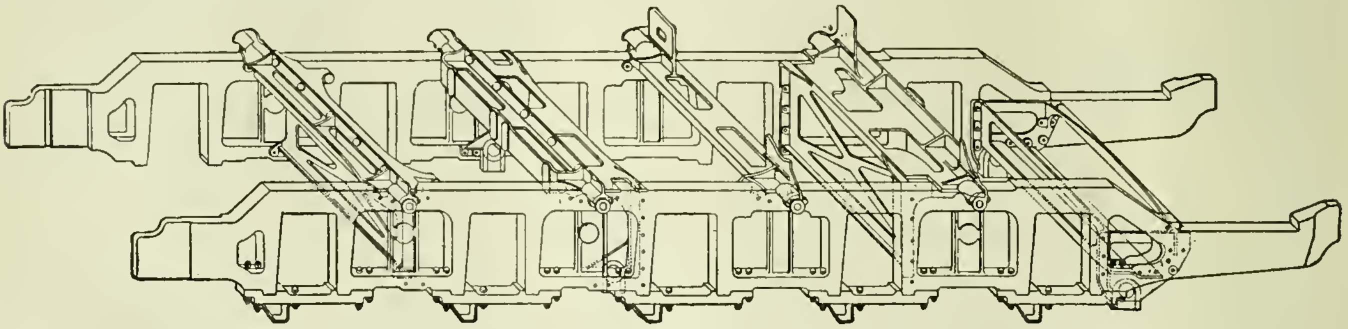


Fig. 4—Frames and Frame Bracing of a Large Locomotive

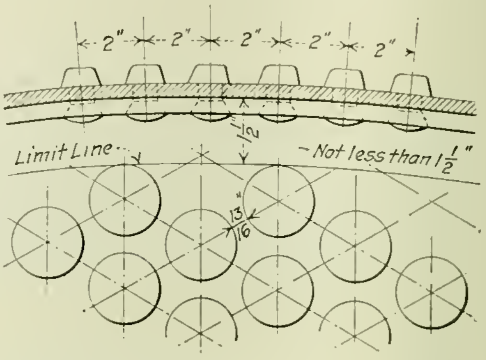
In an effort to overcome these cracks, outside welt plates have been riveted to the boiler to reinforce it where the brace pads are studded on. Experiments have been made with flexible, or partially flexible, braces, some of which have so far been successful.

On engines where breakage of braces has occurred, some of them are being replaced by braces with a pin connection at the lower as well as upper end. Where the use of pins is not favored, however, a thin plate in connection with a cast-steel brace should provide sufficient flexibility for expansion of the boiler and proper stiffness for bracing machinery parts.

The Back Flue Sheet

Boiler back flue sheets of large locomotives are renewed and patched more frequently on account of cracks in the knuckle near the top flange than from any other cause. On at least one road the average life of flue-sheet knuckles is three years and three months, the maximum and minimum varying within rather a large range.

A minimum limit of distance of top flue holes from top of flue sheet that is considered practical is shown in Fig. 5 To omit flues near the top of the flue sheet sacrifices heating surface. To raise the top of the flue sheet above the usual location of flues increases the weight in the firebox, adds to the amount of water necessary to cover the crown sheet, and by requiring increase in diameter of boiler to maintain steam space above the crown sheet, increases the weight of the boiler and consequently the weight of the locomotive as a whole.



NOTE:—Limit line to be increased to 2 in. in designing new boilers where this increase can be made without reducing number of flues, and without reducing bridge below desirable limit

Fig. 5—Minimum Distance Between Top Row of Flues and Flange of Back Flue Sheet

Considering the stresses and the peculiar punishment to which flue-sheet knuckles are subjected, it is important to specify this material carefully. The following limits have been demonstrated by experience as practical:

Tensile strength, 52,000 to 60,000 lb. per sq. in.
Elongation, not less than 25 per cent.
Carbon, 0.12 to 0.25 per cent.
Sulphur, not over 0.025 per cent.

The Ashpan

Various details at the rear of a locomotive should be arranged to permit a large ashpan with smooth slope sheets at an angle that will permit cinders to fall to the hopper without obstruction, and its design should be decided on before the designs of surrounding parts have progressed too far. Equally as important is area between the ashpan and mud ring or through parts of the pan, to admit air to support combustion. This area should be at least equal to the area through the boiler flues, and preferably a little greater.

The Grate Rigging

The place for grate rods, which operate the grates, is near the center of the grates and above the deep portion of the ashpan. On locomotives without stokers this arrangement is not difficult to provide for. With some stokers, however, grate rods in this position are interfered with, and this has resulted in some grate rods being located along the sides of pans, in certain cases very close to the flat portion or shelf of the pan under the mud ring. In this position the rods collect cinders close to the air openings and obstruct the admission of air for combustion. With steam grate-shaker equipment and stoker the grate rods can be located near the center of grates by applying a set of intermediate rockers.

Water Columns

A very thorough investigation into conditions affecting the performance of water columns indicates that the most satisfactory service is obtained with a column and connections conforming with the following specifications:

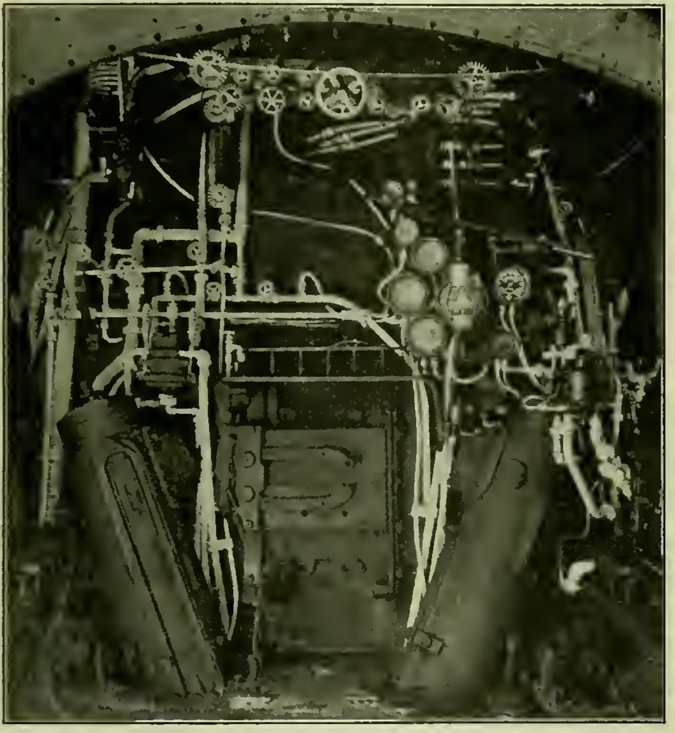


Fig. 6—Location of Boiler Back Head Fixtures in Large Locomotive

Inside diameter of water column, 3½ in.

Inside diameter of top steam pipe, 2 in.

Inside diameter of connection of column to top steam pipe, not less than 2 in.

Inside diameter of bottom connection to boiler, ¾ in.

Top steam pipe as short as possible consistent with required location forward of boiler back head flange.

Minimum number of bends in top steam pipe to column. This pipe to be lagged.

No valves between water column and boiler either in top steam pipe or in bottom connection.

Water-column bottom connection should extend into boiler far enough to clear nearby T-irons or other obstructions, approximately 4½ in. from inside of sheet.

Cab Equipment

The back wall of the cab should be far enough away from the boiler back head to give room for a satisfactory seat, for the application of the required equipment, and for a man to pull the throttle open without striking his arm against it. A distance of 46 in. from the face of back head at the center of fire door to the back wall of cab will meet these requirements.

Engineers' and firemen's seats should be located where the men can see ahead and their vision should not be obstructed by air pumps located too high, classification lamps misplaced, running boards too high at the front, or other obstructions that might interfere with their seeing semaphores, switch stands, etc.

Blow-off cock handles should be so located that they can be operated by a man in position where he can see the water glass, and preferably without leaving his seat. The water glass, steam gage, air gages, etc., should be so located that they can be seen by the engineer when in usual position on his seat.

The throttle lever, power reverse lever, cylinder-cock lever, sander valves, brake valves, etc., should be located where the engineer can reach them handily when sitting in usual position on his seat or sitting with his head out of the window. It appears like a small detail, but it is a worth-while one to locate the straight air valve where it can be reached easily by an engineer when in such a position that he can see a man at the back of the tank giving signals for coupling to a train.

The lubricator must be at such a height that a man can see the feeds, and it must be high enough to avoid pockets in the oil pipes. It must be far enough below the cab roof to be filled easily.

Cab equipment requires careful study and it is difficult to locate the various appliances by drawing, but it has been done. A cab with a large amount of equipment on the boiler back head, yet which is regarded as being reasonably convenient, is shown in Fig. 6.

The use of clear-vision windows has made it somewhat difficult to arrange the seats so that either seat or window will be a height to suit different men. This problem, however, has been solved for one road by its motive-power department chief, who has developed an adjustable seat made of steel and having a spring cushion and an upholstered back. The back being secured to the seat and independent of the back of the cab prevents any vibrations resulting from shaking of the cab wall.

Tender Capacity

Tender capacity should be arranged so as to reduce to a minimum the time a locomotive is detained from the productive work of hauling trains for the purpose of taking water and fuel. This implies large fuel and water capacities, but in arranging for suitable tender capacity care must be taken to avoid unnecessary weight, as any increase in the weight of the tender produces an equal decrease in the weight of train that can be hauled behind the tender.

Tender fuel space should be arranged so as to enable the locomotive to handle a full train with as few stops for fuel as may be feasible.

On territories equipped for water to be taken on the run or when stops for purposes other than taking fuel or water are made regularly at stations where water may be taken. the water capacity should be only sufficient to supply the locomotive when handling a full train, between water stations, with a moderate surplus for unusual delays.

On territories handling a large percentage of through trains with few stops, tenders of large capacity are desirable as they permit keeping locomotives more continuously at work. Where water is scarce and the supply has to be hauled to water tanks, tenders of large capacity are desirable as they reduce the number of water stations that must be maintained as well as the number of locomotives, cars, and men employed in hauling and handling water at these stations.

In addition to reducing time consumed by trains on the road, together with overtime pay to train and engine crews, large-capacity tenders effect a substantial saving by reducing the fuel consumed in starting and accelerating trains as well as the damage to locomotive machinery, draft rigging, tires and rail which frequently results from stopping and starting long freight trains. Train dispatching is simplified and the movements of superior and opposing trains are expedited, as a train which keeps moving interferes less with the movements of other trains than one which must stop frequently, thereby introducing uncertainty as to how long it will be detained.

Necessity for Improvement in the Design and Operation of Present-Day Locomotives

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Mechanical Engineer, Lima Locomotive Works

No one, it is believed, will dispute the fact that present-day operation of high-power locomotives is one of the most vital questions with which our railroads are concerned. The demands of constantly increasing passenger and freight traffic have brought about a constant increase in size and power of our locomotives.

In view of the rapid strides that have taken place in increasing the size and power of locomotives within the last few years, it seems rather out of place to predict that the maximum has been reached. It is also true that the use of improved devices has made possible the satisfactory operation of the large locomotives of today. Everything seems to indicate that we have not reached the maximum capacity of the locomotive even within the present limits of clearance and rail load, and we may expect to see these same engines made far more powerful and economical by the application of devices which are now available or which are already being given serious attention.

In view of the foregoing, the most vital matter which confronts locomotive designers and operating officials is that of increasing the capacity as well as the efficiency of the locomotives which we have today. In many ways these problems have already been attacked and great improvements are continually being made.

In the following paragraphs an attempt will be made to bring to attention some of the problems which our present day locomotives bring forth and upon the proper solution of which depends their success.

Combustion and Steam Generation

In order that large engines may operate properly, it is of course necessary that a sufficient supply of steam be furnished to cylinders so that they can be made to produce their maximum horsepower. It is not enough to provide a given number of square feet of heating surface in the firebox and the tubes so that we may be reasonably certain that sufficient water will be evaporated to supply the cylinders. It is, however, necessary that we take into account proper construction of the boiler, necessary firebox volume to produce the best possible combustion of fuel, and the design of grates so that fuel will be economically burned to such an extent only as required by the maximum evaporation of the boiler.

In producing heavy motive power it has been necessary on account of prohibitive axle loads to apply a sufficient number of axles under the engine to reduce the individual axle load to within reasonable limitations. This has lengthened out the engine to such an extent that boiler design and maintenance has become a serious problem. In the first place, it is necessary to design a boiler that will properly function with the other vital parts of a locomotive. At the same time the length has become such that the use of combustion chambers is a necessity to avoid a prohibitive length of tube. Large engines have been constructed with a tube length of 25 ft. and it seems that no definite rule has been established as to what the limit of length of tube of a given size should be. Experiments have been made on this subject and it has been said that the maximum length in inches of a tube of a given size should be approximately 100 times its diameter in inches. It would seem that this is as nearly correct as any general rule which has been devised and one which can be readily followed.

The author does not feel that any definite rule should be made in regard to length of tubes, for this might bring about a condition whereby other vital features of the engine would be involved in order to abide strictly to the length as noted above. Tubes 2 or 2¼ in. in diameter in excess of 20 ft. in length are questionable, and this feature should be looked into carefully before a decision is reached.

The advent of long combustion chambers has brought along with it the necessity for increased attention to boilers. The application of a long combustion chamber requires a large number of additional staybolts and it would naturally be expected that a boiler of this kind would require more staybolt attention. For this reason, if for nothing else, there is no doubt that a proper installation of flexible stays in the firebox and combustion chamber will prevent a great deal of the staybolt trouble which has been experienced in the past. Although long combustion chambers require more attention in maintenance this will be offset by the increased firebox volume and the resulting better combustion.

On account of height limitations, the height of the dome as well as the steam space in the boiler has been reduced to such an extent that difficulties are being encountered with the proper life and maintenance of superheater equipment, because too much water is drawn over through the throttle into the superheater. This is a question requiring experiment to determine as nearly as possible the minimum steam space which should be provided for boilers working on various grades. Consideration should also be given to the height of the throttle above the water line as well as to the steam space in the boiler. Considerable development on this subject is now well under way and we can confidently expect results of value in the near future.

Increased Capacity Needed Without Increase in Size

As noted above, it seems that we have about reached the limit of size of cylinders and size of boiler due to road clearances. To undertake to provide additional road clearance on practically all of the main lines today would mean a total expenditure of money, entirely out of proportion to the benefits that would accrue.

On account of the apparent limitations of piston thrust and road clearances the greatest problem with large locomotives today is to increase their capacity without exceeding greatly present sizes. Anything to increase the hauling capacity of the locomotive without increasing the height and width limitations under which the locomotive must work might be called an essential capacity-increasing device. A few of these with which we are most familiar and which have proved beyond doubt their desirability are the superheater, the brick arch and the mechanical stoker. There are possibilities of still increasing the efficiency of the superheater without increasing the size of the boiler in which it must operate. There are also possibilities and constant improvements in the design of brick arches which lend to higher evaporation and better combustion of fuel. It has been stated that when a locomotive requires as much as 6,000 lb. of coal per hour it has gone beyond the limits of the ordinary fireman. Automatic stokers have been in use so long that their dependability for heavy power is no longer in question. Many men are studying this particular feature of locomotive design and operation and we may confidently expect in the future a gradual increase in the efficiency of these mechanisms. As they stand today they are an unqualified success, and time and study will bring about the necessary refinements so that better combustion and less coal per horsepower will be used.

We have not as yet gone very extensively into the use of feedwater heaters. It has been proved without a doubt in foreign countries that the feedwater heater is an essential capacity-increasing device as well as an economical addition to the locomotive. In this respect, then, it would seem that we are somewhat behind the Europeans, and there is no doubt that in the near future when the economies that can be effected by the use of feedwater heater are realized it will become almost as general as the superheater today.

Another small item which has received only passing attention in this country is the variable exhaust. As is well known, a variable exhaust that can be properly operated and which will not require much maintenance attention will have a great tendency to relieve high back pressure at high speeds, and its operation will also provide the necessary draft at slow speeds. It is one of the small things that deserves consideration and study and something which it is felt will be worked out satisfactorily for the future.

The Engine Proper

There have been no radical changes in the general design of cylinders. The use of outside steam pipes has resulted in advantages both from a casting and maintenance standpoint. It would seem well worth while to consider a design of cylinder by means of which the weight could be reduced to a great extent, permitting of additional weight of other parts, and thereby increasing the capacity of the locomotive.

The design of valve gears has received a great amount of attention and many accepted types are now available. In all of these every effort has been to better the steam distribution. In maintenance we are far ahead of engines used twenty years ago. There is yet, however, much to be desired in steam-distribution and this subject will bear as careful study in the future as it has in the past.

Power Transmission

When we consider that as much as 150,000 lb. piston thrust is being transferred through a single main rod and from this into the driving wheels of a locomotive, it is not difficult to understand why troubles are experienced with main crankpins and particularly side rod bearings at the main pin. In order to provide the proper strength to take care of this tremendous piston thrust it has been necessary to design extremely heavy main and side rods. The piston thrust is not the only consideration in this connection. The inertia forces, particularly in drifting, at times reach figures that are even greater than the piston thrust. Practically all of this must be taken care of through the main crank pin and the necessary connections to the side rods at this point.

All are familiar with the large number of experiments which have been carried on to produce a steel that would give a higher elastic limit than the ordinary high-carbon open-hearth steel which was successfully used until engines reached their present proportions. The use of such steel for side rods, main rods and piston rods has been principally confined to heat-treated and quenched forgings, which permitted the use of sections which were considerably lighter than what could be used with the ordinary open-hearth annealed forgings. Steel has also been produced which gives a high elastic limit and which can be successfully used with ordinary annealing, permitting very considerable reductions in weight compared to the ordinary open-hearth steel formerly employed. The use of such a steel does away with quenched forgings and permits of rods being heated for closing in straps and similar work without destroying the quality of the material as is the case with quenched forgings.

Main and side rods have been produced and have been in successful operation for the past few years in which the piston thrust is carried directly from the main rods to the side rods back of the main wheel. This does not in any way reduce the piston thrust that must necessarily come on the main rods. At the same time, however, it does reduce very considerably the piston thrust that must be transferred through the main crank pin into the side rods, thereby alleviating to a very great extent the troubles that have been experienced with large side rod connections at the main pin. Such a design does not increase the total weight of the rods to an extent likely to cause any appreciable increased difficulties from a counterbalance standpoint.

The design of main and side rods as well as main crank pins will always be a vital question in the construction of locomotives. It has been necessary and always will be in designing the rods for locomotives to assume certain arbitrary limits of fiber stress based principally upon past experience. It is impossible to take into account all the stresses produced in rods when a locomotive is in operation, and for this reason the allowable fiber stresses in tension, compression and bending must be taken comparatively small in comparison to the elastic limit obtained in such forgings.

There has already been a great deal written and a number of experiments conducted regarding the proper design of rods to successfully stand up under severe usage and at the same time reduce to a minimum the ordinary difficulties presented from the standpoint of counterbalance. Hollow-bored piston rods, light designs of crosshead and piston, the use of high-tension steel for side and main rods as well as the use of hollow-bored crank pins are familiar to all. More careful attention should be paid to the quality and upkeep of rod bearings and every endeavor should be made to provide bearings of such quality and design that renewals will be reduced.

A main pin designed properly for heavy piston thrust must be so proportioned that the length will bear a certain relation to the diameter within very close limits. On account of the necessity for keeping cylinder centers as close together as possible because of road clearances, if a proper length of main pin is obtained, its proper size presents a difficult proposition. This is one of the great difficulties which the author is confident will be overcome in the near future by the proper application of a design previously mentioned, wherein a large part of the piston thrust is transmitted directly from the main rod into the side rod.

Before the advent of present day large locomotives with their tremendous piston thrust it was not a particularly difficult matter to design a suitable main crank pin. So long as the bearing pressure per square inch of projected area based upon maximum piston thrust was within a limit of 1,600 or 1,700 lb. the main pins would work satisfactorily. The ordinary design of smaller locomotives was such that the main side pin would also be sufficient. It has been found in comparatively recent years, however, that the old rule would no longer apply. In order for the main crank pin to be of sufficient size to withstand heavier piston thrust and still maintain the fiber stress within workable limits, it was necessary of course to increase the diameter proportionately. This brought up the question of rubbing speed. It is a well-known fact that if the rubbing speed is too high, bearings will heat and wear very rapidly regardless of the bearing pressure.

Counterbalance

It is a very difficult matter to separate the question of counterbalance from the design of connecting rods and reciprocating parts. There is a great diversity of opinion in regard to the proper amount of counterbalance which should be applied to locomotives. There are in operation heavy Santa Fe type locomotives which have between 35 and 40 per cent of the reciprocating weights counterbalanced and they are said by traveling engineers to ride easily. The author believes that with our present heavy engines with long wheelbase it is not necessary to balance as much as 50 or 55 per cent of the reciprocating weight. In fact, it is quite possible that we may be able to counterbalance a smaller percentage of reciprocating weight than has heretofore been attempted, especially for long, heavy engines, provided the revolving weights at the main pin can be properly taken care of. Every effort, however, should be made to balance all of the revolving weights on the main pin. If, for example, we lack 400 lb. of balancing the revolving weight on the main pin, the effect on the track is exactly the same as if we had 400 lb. of counterweight on any of the other wheels to balance reciprocating parts.

There is an added difficulty to this problem, because the action of the counterweight in wheels other than the main is exactly opposite to the force produced by the weight on the main pin which is not counterbalanced. This condition results in increased track stresses, as well as increased stresses in frames and other parts of the locomotive. There is also a tendency at high speeds when a condition like this exists for the main wheel to lift from the rail, while the wheels other than the main are exerting their maximum force on the rail. This reduction of weight on the main wheel at the time when the other wheels are exerting their maximum force on the rail provides a tendency for the main wheel to slip when it is impossible to slip the remaining wheels. No one, it is believed, can give any idea of the stresses which are produced in side rods, frames and other parts of a locomotive due to a condition of this kind. In fact, there have been instances where the rods were torn off and the crank pins loosened for this reason alone.

The author is of the opinion that no definite set rule can be established in this regard, but that each particular design is a study in itself, and wherever revolving weights at the main pin are encountered such that they cannot be properly counterbalanced, steps should be taken to provide the best means possible of reducing revolving weights at this point as well as providing reciprocating parts as light as possible consistent with strength. This of course has been accomplished in the past by hollow boring the main pins and piston rods and by using a light design of piston head, which indicates that a steel having a high elastic limit with the proper elongation and reduction of area should be employed. The use of such steel has already proved that it can be depended upon. One of the principal fundamentals in counterbalance is to keep the reciprocating weight as light as possible.

The Running Gear

On account of the large increase in the size of cylinders of present-day heavy locomotives over those used several years ago, the cylinder centers have been spread until they have reached practically the clearance limitations of the railroads, and the necessity for larger journals to carry properly the increased axle loads has caused the frame centers to be brought nearer together.

This condition increases very materially the distance from the center of the cylinder to the center of the frame, which of itself produces greater strain in the frame and at the same time increased pressure on the driving-box bearings as well as shoes and wedges. In addition to the above, piston thrusts have increased from approximately 65,000 lb. to approximately 150,000 lb., and means must be provided to properly take care of the increased piston thrust along with the increased overhang.

While discussing the subject of frames it is hardly possible to ignore the vital question of frame cross-bracing. Substantial and sufficient cross-braces should be applied between the frames and rigidly bolted thereto to form a rugged structure which will not rattle to pieces. Sufficient bearing for bolts and adequate bolting flanges are a very important feature. At the same time it must be borne in mind that there is a possibility of tying up the frame so rigidly that there will be a tendency for failures ahead of the front pedestal and just back of the cylinder fit at a point where it is practically impossible to obtain sufficient reinforcement.

It seems as though the design of driving boxes and driving-box brasses has not successfully kept pace with the rapid increase in piston thrust. We have in almost general use the same type of driving-box brass which has been standard on locomotives for years. The design is such that the brass extends about half-way down over the journal. Inasmuch as this brass must take up the piston thrust, it is very evident that we shall have trouble in taking care of driving-box brasses until a suitable design is produced—one in which the brass will cover much more of the front and back projected area of the journal than is now the case.

Guiding and Trailing Trucks in Connection with Long Wheelbase

With our present heavy Mikado and Santa Fe type locomotives the length of rigid wheelbase is almost if not quite double the rigid wheelbase in ordinary service 20 years ago. It is unnecessary to comment upon the fact that it is a difficult matter to operate such engines around curves of even comparatively small degree and at the same time prevent the rapid wear of hub liners and driving-box faces, thus increasing quickly the lateral play to a prohibitive point and necessitating work in the shop to overcome it.

Santa Fe type engines with 22-ft. rigid wheelbase are not uncommon. Engines of this type and of this size will weigh in the neighborhood of 400,000 to 420,000 lb. When we stop to think that to move this tremendous mass of material around a 16- or 18-deg. curve a force of many thousand pounds is required, is it any wonder that we obtain rapid flange wear and the necessity for re-turning tires before the proper amount of mileage has been obtained? In the majority of cases, it is believed, the force necessary to properly curve an engine of this kind has been applied at the front truck and the first driver. In most cases types of leading trucks have been used which produce a very small resistance on curves of small degree. In order to prevent rapid flange wear as well as to overcome the development of lateral play unnecessarily, designs have been produced which will give a high initial resistance of the front truck and provide a lateral motion for the front driver with adequate resistance so that some of the guiding force is transferred back to the second pair of drivers.

Since locomotives operate the greater part of the time on tangent tracks, it is necessary to have a high initial guiding resistance which will not be increased when curving. In other words, a flexible wheelbase is produced which has all the requisites of the ordinary rigid wheelbase, but at the same time will overcome many of the difficulties now encountered in an attempt to operate engines of this size and length. Many designs of trailing trucks have been produced with the idea in mind of helping to remedy the conditions which have been noted above. These of course have met in a way the conditions which it was necessary to overcome. There is much yet to be done in producing a trailing truck which will have the proper facilities for equalization of spring rigging and at the same time produce an initial guiding force which can be kept nearly constant, thus avoiding the high final lateral resistance which is found in a good many of the trailing trucks now in use.

In addition to the foregoing some work has been done in the way of producing a design by means of which the lateral play in locomotive driving wheels can be taken up without removing the wheels from under the engine or taking the boxes off from the axles. No doubt in the near future a practical device of this kind will be produced. This is another one of the many problems which can be worked out which will enable the railroads to keep their locomotives in service.

The advent some years ago of the power reverse gear overcame one of the great objections that engineers had to large locomotives. It is a fact that it is almost impossible for one man to reverse one of our large locomotives equipped with the ordinary hand reverse lever. Power reverse has come to be an essential part of engine equipment and has been found to be economical even though it may be used on a locomotive which could be comparatively easily reversed by hand.

Probably no one thing contributes more to the failure of side rods than the improper adjustment of shoes and wedges. If these are allowed to run loose, stresses in the side rods will amount to a very high figure and it is impossible to determine to what extent they may go. A satisfactory automatic wedge if properly applied and maintained will, no doubt, go a long way toward preventing side rod failures.

Means for Increasing Nominal Tractive Power

All railroads have points on certain divisions where there is a critical grade or the necessity of starting a heavy load under adverse conditions. At such places increased tractive power is required which is not needed elsewhere. We are therefore confronted with the problem of producing a device which can be set to work to increase the tractive power of a locomotive to such an extent that the critical grade or the necessity for increased tractive power to start a train under adverse conditions will be overcome, thus enabling the engine to take its full tonnage over the entire division. This device should be so made that it can be applied when necessary and thrown out when the additional tractive power is not required. Designs have already been produced wherein an additional tractive power of 8,000 or 10,000 lb. has been applied to the trailing trucks of large locomotives. There is also a possibility of applying such a device to the tender truck, thus availing ourselves of the adhesive weight of the tender to help boost the engine over the critical points in a division. There is always present a possible potential boiler capacity which can be brought out by the use of a variable exhaust or other device sufficient to obtain rapid combustion at slow speeds.

What has already been done along this line may be taken as a start in the right direction. A certain amount of development work must be done in order that these necessary improvements may be made to operate satisfactorily. These problems require the co-operation of the railroads to provide the necessary means for trying out such devices which, after having been carefully considered, show that they have possibilities for future use.

The Ash Pan

The question of ash pans is also one needing serious consideration. With the large increase in size of locomotives in many cases we have evidently lost sight of the importance of this necessity. There are in use a number of rules stating what the proper air opening in the ash pan should be, some saying that the ash pan air opening should be equal to the net gas area of the tubes and others that it should be a certain percentage of the opening through the grates. While many of these rules have in a way proven satisfactory, at the same time it would seem that to get at the question logically we should determine the amount of coal that can be burned economically per square foot of grate and then on this basis provide an ash pan air opening that will give the required amount of air to burn satisfactorily the maximum amount of coal which is expected to be consumed. The amount of air that will flow through a given opening in the ash pan, it is believed, can be very closely approximated from the vacuum produced in the smokebox. This, of course, is only a suggestion, and it may be that when the question is looked into more carefully a more desirable and accurate method of determining the required ash pan air opening for proper combustion may present itself.

Lubrication

Lubrication is a subject which has received much attention and a great number of combinations and experiments have been made to determine the most satisfactory method. With our present high superheat the proper introduction of oil into the cylinders and valves of a locomotive is worth serious consideration.

It is common practice in European countries to provide a forcefeed lubricator located very close to the cylinder. The ordinary method which they use in connecting up this lubricator is to provide a pipe to each end of the piston-valve steam chest. This oil supply opens directly over each end of the valve when it is in central position. In addition an oil pipe is supplied to the cylinder at its center. It is reported that by this method there is less carbonization of the oil than when it is fed into the steam pipes or into the center of the piston valve steam chest. Whether or not this is so the author has no means of proving, but it seems logical.

In order to increase the tonnage which a locomotive can haul it is just as vital to decrease the resistance as to increase the power. It is not an impossibility to provide roller bearings for passenger cars and there seems to be no reason why they cannot be used on freight cars. Of course, this would mean very radical changes in design and a gradual displacement of present equipment, but the reduction of rolling resistance and the better facilities for lubrication which would be provided would be sufficient in time to overcome the necessary expense. All this may seem rather far-fetched, but it is at least worthy of consideration.

Conclusion

In summing up the situation, it may be said that the use of the superheater alone has increased the capacity of locomotives when compared with saturated engines of the same design to such an extent that no one would think of building a large locomotive for up-to-date railroad service without the application of superheat. This is one of the greatest strides that has been made in the construction of locomotives in the past few years. We must not content ourselves, however, with what has been done with this one device. The large locomotive of today has become a necessity and is here to stay. What we need to do now is to avail ourselves of the opportunities offered in the application of many of the labor-saving and capacity-increasing devices which have already been worked out and are giving satisfactory service and at the same time look forward to the possibilities of applying other devices which are yet in their infancy, but which have proven beyond doubt that they are well worth our consideration and are of sufficient importance to warrant their adoption. There are many improvements yet to be made in locomotives and it behooves the operating officials of railroads as well as the leading minds in locomotive operation and design to get together and to continue to produce locomotives which in the next 20 years will be as far ahead of our present engines as our present locomotives are ahead of the locomotives that were built 20 years ago. Without the capacity-increasing devices which have been mentioned the large locomotive of today would be impossible—it could not be operated satisfactorily. Our large engines are an absolute justification of these improvements. Further developments are ready at hand and in their use lie the possibilities of still more powerful and economical transportation units built to operate within our present limitations of clearance and permissible rail loads.

The Functions of Management

Functional organization and management was the subject considered by the New York Section of the Taylor Society, on April 21, as reported in the Iron Age. The chief speaker was Henry W. Shelton, who had gained experience in his subject as assistant professor of organization and management at the Amos Tuck School of Administration and Finance, Dartmouth College; as head of the personnel section on the staff of the vice-president in charge of administration in the Emergency Fleet Corporation, and as consulting engineer in charge of the reorganization work at the Wilmer-Atkinson Company, Philadelphia.

Industry may be likened to an equilateral triangle, the speaker declared, one side being represented by thinking; the second, by feeling, and the third, by doing. In the past we have not known how to organize the feeling side of industry. In its first stage we had an unorganized, decentralized activity. We have now reached the second stage, where production is organized and centralized. And we are just getting into a third stage where particular functions are recognized and are being redistributed among individuals in a sensible way—in other words an organized, decentralized activity. Part of what he said is in substance as follows:

Authority must rest on knowledge of fitness—no longer on "dignity" of position. Don't keep hard and fast to any one group of standards. Keep re-analyzing and changing them as new personnel bring to the task greater or less powers. Open-mindedness to criticism is very essential. Every workman should be an inspector. Publicity is a great factor for promoting harmony.

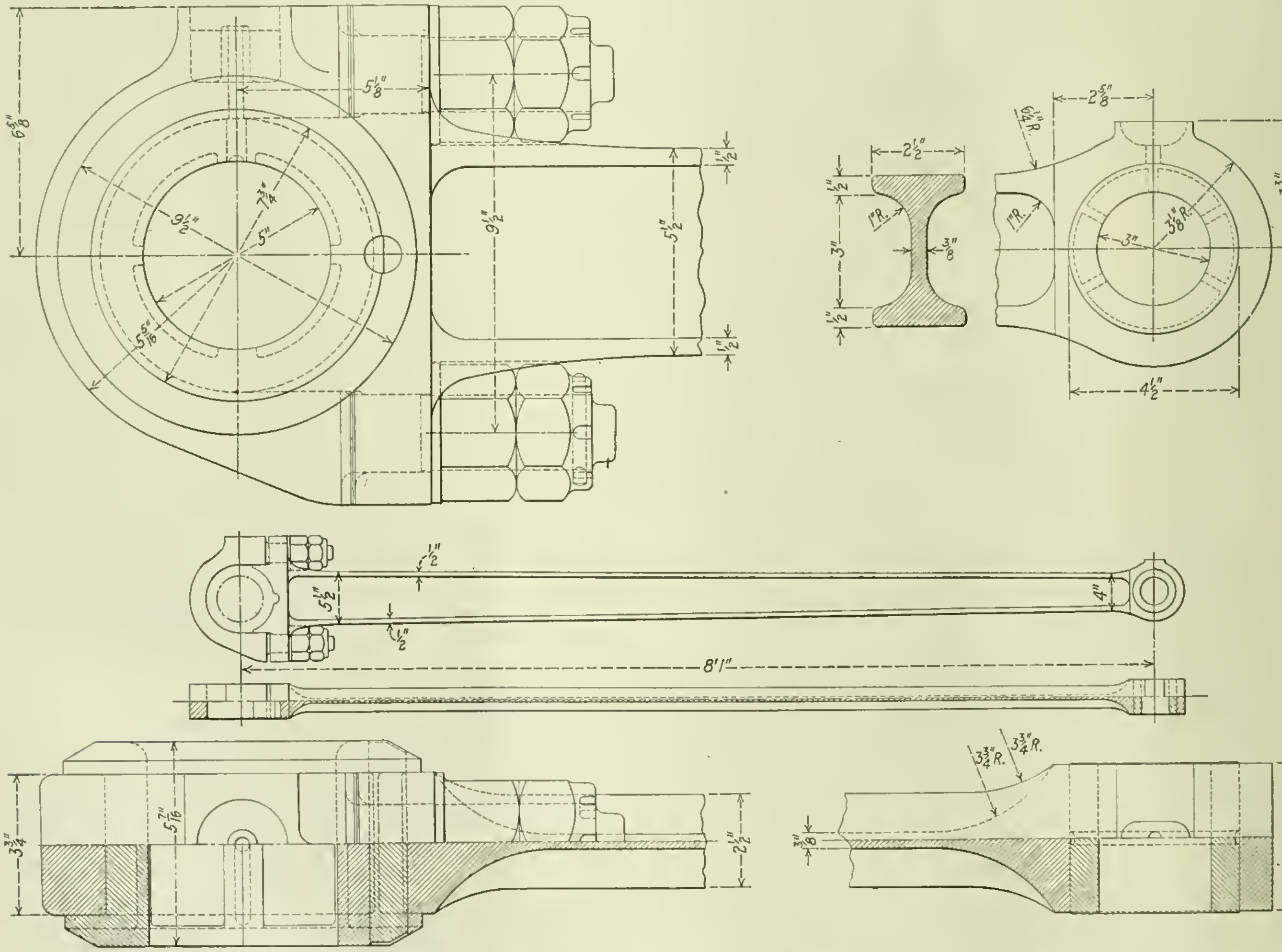
An Accomplishment in Light Reciprocating Locomotive Parts

While the possibilities of alloy steels as a means for reducing the weight of reciprocating parts of locomotives are well known in this country, it would seem that refinements actually accomplished abroad far surpass progress in this direction on American railroads. We are indebted to officers of the mechanical department of the Great Northern Railway of England for the accompanying drawing of the outside connecting rod designed for a new three-cylinder 2-6-0 type locomotive recently placed in service on that railroad.

The three cylinders used on the new locomotives are each 18½ in. in diameter with a 26-in. stroke as compared with two 20-in. by 26-in. cylinders on earlier 2-6-0 type locomotives. The rods for the old locomotives were of carbon steel and weighed 403 lb. each whereas the rods for the new locomotives are of nickel chrome steel and weigh only 295 lb. each. The dimensions and results of tests to which both rods were subjected are given in the following table together with the analysis of each.

	Carbon Steel Rod	Nickel-Chrome Steel Rod
Length	8 ft. 1 in.	8 ft. 1 in.
Weight	403 lb.	295 lb.
Yield limit (tons per sq. in.)	17.0	48.4
Breaking strength (tons per sq. in.)	33.6	58.0
Elongation	.84 in.	.40 in.
Diameter at point of fracture	.53 in.	.37 in.
Reduction of area	56 per cent	57.2 per cent
Ratio, yield limit to breaking limit	50.6 per cent	83.4 per cent
Analysis:		
Carbon	.28	.33
Silicon	.168	.21
Manganese	.686	.60
Sulphur	.033	.032
Phosphorus	.034	.039
Nickel	....	3.42
Chromium	....	.60

Particular attention was given in designing the rods to avoid sudden changes of section and especially sharp corners: the large radii used will be noticed. The strap ends were screwed with a round thread for the same reason. The rods were rough forged and then rough machined to within a quarter of an inch of the full size. They were then returned to the makers and heat treated and then machined to the finished size.



Light Weight Alloy Steel Main Rod Used on Three-Cylinder Locomotives of the Great Northern Railway of England

Principles to Govern Agreements Defined by Labor Board

Decision Terminating National Agreements on July 1 Instructs Officers and Employees to Draw Up New Rules

THE long controversy over the railway employees' demand for the perpetuation of national agreements was ended on April 14 by a decision handed down by the Railroad Labor Board which sustained some contentions of both the carriers and the employees. The award abrogated national agreements, remanded the negotiation of new agreements to the individual carriers and their own employees, and upheld the railroads' interpretation of the principle of collective bargaining and their contention that varying local conditions should govern the fixing of rules and working conditions. In these respects the decision was favorable to the railroads. The award also outlined sixteen principles with which the new agreements should be consistent. This constitutes one of the chief points for which the employees' representatives have been fighting. Accordingly both sides have expressed satisfaction with the terms of the decision.

The hearings prior to the decision, following the cross-examination of General Atterbury as described in the April issue, were uneventful. Voluminous exhibits were presented by W. Jett Lauck, consulting economist of the labor organization. The cross-examination of railroad executives was continued and Frank McManamy, formerly assistant director, mechanical department, division of operation of the Railroad Administration, was called to testify. Judge R. M. Barton, chairman of the board, was called to a conference at Washington with President Harding and Edgar E. Clark, chairman of the Interstate Commerce Commission.

Before the decision was announced, the Labor Board served notice that April 18 would be set as the date of hearing in the disputes between the railroads and the employees over wage scales.

S. Higgins W. L. McMenimen B. W. Hooper

Three New Members of the Labor Board

Text of the Board's Decision on National Agreements

After outlining the history of the controversy the decision said in part:

The evidence and arguments submitted in this case support the following conclusions:

The duty imposed by Section 301 on all carriers and their officers, employees and agents to consider and if possible to decide in conference all disputes between carriers and their employees has not been performed by the parties hereto either with regard to the wage or the working conditions portion of this dispute. The record shows that the representatives of the carriers were unwilling to assume the responsibility of agreeing to substantial wage increases. Hence, the conference of March 10 to April 1 on the side of the carriers was merely a perfunctory performance of the statute. Nor was the action of the organizations with regard to the individual carriers more than perfunctory. Naked presentation as irreducible demands of elaborate wage scales carrying substantial increases, or of voluminous forms of contract regulating working conditions, with instructions to sign on the dotted line, is not a performance of the obligation to decide disputes in conference if possible. The statute requires an honest effort by the parties to decide in conference. If they cannot decide all matters in dispute in conference, it is their duty to there decide all that is possible and refer only the portion impossible of decision to this Board.

Although Section 301 has not been complied with by the parties, the Board has jurisdiction of this dispute, as it is and has been one likely substantially to interrupt commerce.

The carriers parties hereto maintain that the direction of this Board in Decision No. 2, extending the national agreements, orders, etc., of the Railroad Administration as a *modus vivendi* should be terminated at once; and that the matter should be remanded to the individual carriers and their employees for negotiation and individual agreement.

The organizations maintain that the national agreements, orders, etc., with certain modifications desired by the employees should be held by this Board to constitute just and reasonable rules; and should be applied to all carriers parties to the dispute, except to the extent that any carrier may have entered into other agreements with its employees. They maintain that local conferences requiring necessarily the participation of thousands of railroad employees for several weeks would constitute an economic waste and would produce a multiplicity of controversies as well as irritation and disturbance. They also urge that to require local conferences would be to expose the local organizations on the several carriers to the entire power and weight of all the carriers acting through the Association of Railway Executives on the conferring carrier, that such a disparity of force would produce an inequitable result highly provocative of discontent and likely to result in traffic interruptions. They, accordingly, insist that the conference should be national.

The carriers maintain that rules negotiated by the employees and officers who must live under them are most satisfactory, that the participants in such negotiations know the intent of the rules agreed to and advise their fellow workmen and officers accordingly thereby avoiding a litigious attitude on both sides, that substantial differences exist as between the several carriers with relation to the demands of the service, necessary division of labor and other factors which differences should be reflected in the rules, that these local differences can be given proper consideration only by local conferences. The carriers refuse to confer nationally.

The Labor Board is of the opinion that there is merit in the contentions of each party and has endeavored to take action which will secure some of the advantages of both courses.

This Board is unable to find that all rules embodied in the national agreements, orders, etc., of the Railroad Administration constitute just and reasonable rules for all carriers parties to the dispute. It must, therefore, refuse the indefinite extension of the national agreements, orders, etc., on all such carriers as urged by the employees.

This Board also deems it inadvisable to terminate at once its direction of Decision No. 2 and to remand the dispute to the individual carriers and their employees. Such a course would leave many carriers and their employees without any rules regulating working conditions.

If the Labor Board should remand the dispute to the individual carriers and their employees and should keep the direction of Decision No. 2 in effect until agreements should be arrived at, it is possible that agreements might not be arrived at.

The Labor Board believes, nevertheless, that certain subject matters now regulated by rules of the national agreements, orders, etc., are local in nature and require consideration of local conditions. It also believes that other subject matters now so regulated are general in character and that substantial uniformity in rules regulating such subject matters is desirable.

The Board also believes that certain rules are unduly burdensome to the carriers and should in justice be modified. It may well be that other rules should be modified in the interest of employees.

To secure the performance of the obligation to confer on this dispute, imposed by law on officers and employees of carriers, to bring about the recognition in rules of difference between carriers where substantial, to preserve a degree of uniformity in rules regulating subject matters of a general nature, to prevent to some extent the operation in negotiations of a possible disparity of power as between the carriers and their employees, and to enable the representatives of employees of each carrier and the officers of that carrier to participate in the formulation of rules under which they must live, the Labor Board has determined upon the following action.

Decision

1. The direction of the Labor Board in Decision No. 2, extending the rules, working conditions and agreements in force under the authority of the United States Railroad Administration, will cease and terminate July 1, 1921.

2. The Labor Board calls upon the officers and system organizations of employees of each carrier parties hereto to designate and authorize representatives to confer and to decide so much of this dispute relating to rules and working conditions as it may be possible for them to decide. Such conferences shall begin at the earliest possible date. Such conferences will keep the Labor Board informed of final agreements and disagreements to the end that this Board may know prior to July 1, 1921, what portion of the dispute has been decided. The Labor Board reserves the right to terminate its direction of Decision No. 2 at an earlier date than July 1st with regard to any class of employees of any carrier if it shall have reason to believe that such class of employees is unduly delaying the progress of the negotiations. The Board also reserves the right to stay the termination of the said direction to a date beyond July 1, 1921, if it shall have reason to believe that any carrier is unduly delaying the progress of the negotiations. Rules agreed to by such conferences should be consistent with the principles set forth in Exhibit "B," hereto attached.

3. The Labor Board will promulgate such rules as it determines just and reasonable as soon after July 1, 1921, as is reasonably possible and will make them effective as of July 1, 1921, and applicable to those classes of employees of carriers parties hereto for whom rules have not been arrived at by agreement.

4. The hearings in this dispute will necessarily proceed in order that the Labor Board may be in position to decide with reasonable promptness rules which it may be necessary to promulgate under Section 3 above.

5. Agreements entered into since March 1, 1920, by any carrier and representatives of its employees shall not be affected by this decision.

Sixteen Principles to Govern in New Agreement

Exhibit "B," mentioned above, sets forth the principles believed by the Board to be just and reasonable in governing working conditions as follows:

1. An obligation rests upon management, upon each organization of employees and upon each employee to render honest, efficient and economical service to the carrier serving the public.

2. The spirit of co-operation between management and employees being essential to efficient operation, both parties will so conduct themselves as to promote this spirit.

3. Management having the responsibility for safe, efficient and economical operation, the rules will not be subversive of necessary discipline.

4. The right of railway employees to organize for lawful objects shall not be denied, interfered with or obstructed.

5. The right of such lawful organization to act toward lawful objects through representatives of its own choice, whether employees of a particular carrier or otherwise, shall be agreed to by management.

6. No discrimination shall be practiced by management as between members and non-members of organizations or as between members of different organizations, nor shall members of organizations discriminate against non-members or use other methods than lawful persuasion to secure their membership. Espionage by carriers on the legitimate activities of labor organizations or by labor organizations on the legitimate activities of carriers should not be practiced.

7. The right of employees to be consulted prior to a decision of management adversely affecting their wages or working conditions shall be agreed to by management. This right of participation shall be deemed adequately complied with, if and when, the representatives of a majority of the employees of each of the several classes directly affected shall have conferred with the management.

8. No employee should be disciplined without a fair hearing by a designated officer of the carrier. Suspension in proper cases pending a hearing, which shall be prompt, shall not be deemed a violation of this principle. At a reasonable time prior to the hearing he is entitled to be apprised of the precise charge against him. He shall have reasonable opportunity to secure the presence of necessary witnesses and shall have the right to be there represented by a counsel of his choosing. If the judgment shall be in his favor, he shall be compensated for the wage loss, if any, suffered by him.

9. Proper classification of employees and a reasonable definition of the work to be done by each class for which just and reasonable wages are to be paid is necessary, but shall not unduly impose uneconomical conditions upon the carriers.

10. Regularity of hours or days during which the employee is to serve or hold himself in readiness to serve is desirable.

11. The principle of seniority long applied to the railroad service is sound and should be adhered to. It should be so applied as not to cause undue impairment of the service.

12. The Board approves the principle of the eight hour day, but believes it should be limited to work requiring practically continuous application during eight hours. For eight hours' pay eight hours' work should be performed by all railroad employees except engine and train service employees, regulated by the Adamson Act who are paid generally on a mileage basis as well as on an hourly basis.

13. The health and safety of employees should be reasonably protected.

14. The carriers and the several crafts and classes of railroad employees have a substantial interest in the competency of apprentices or persons under training. Opportunity to learn any craft or occupation shall not be unduly restricted.

15. The majority of any craft or class of employees shall have the right to determine what organization shall represent members of such craft or class. Such organizations shall have the right to make an agreement which shall apply to all employees in such craft or class. No such agreement shall infringe, however, upon the right of employees not members of the organization representing the majority to present grievances either in person or by representatives of their own choice.

16. Employees called or required to report for work, and reporting but not used should be paid reasonable compensation therefor.

Following the announcement of the award, spokesmen for the labor organizations hailed it as a complete victory. At the same time E. T. Whiter, chairman of the committee representing the railroads before the Board, in commenting on the decision said in part:

> The decision reached has given opportunity for arrangements between individual railways and their employees which can be made much more reasonable than the rules and working conditions established by the national agreements, and which in a large measure can be adapted to the local conditions of each carrier. * * * The entire tenor of the Board's decision is

that the railways should be economically operated, that employees should render efficient labor for all the time for which they are paid, and that the artificial "pyramiding" of wages, which under the present rules has resulted in large waste, shall cease.

Wage Hearings Begin

In accordance with an order of the Board, the wage question was reopened on April 18 when hearings were started to determine what constitutes a just and reasonable wage under present conditions for various classes of employees. At the time the Board's announcement was made, disputes between 26 railroads and their employees had been certified. When the hearings began the Board had docketed 92 disputes. These were consolidated into one case although each carrier was granted the right to make a separate presentation.

The fact that the three new members of the Board were not present at the beginning of these hearings led to vigorous but ineffective protests against the opening of the case on the part of representatives of the employees. The Board did, however, grant a time concession in allowing the carriers and unions, instead of one day each for the presentation of their cases, as it had announced, five days each for this purpose. The Board also ruled that there would be a week's intermission between the carriers' presentation and that of the unions and that an additional week would be allowed for rebuttal.

The railroad's arguments for wage reductions were opened by J. G. Walber, speaking on behalf of the eastern carriers and taking up those arguments which are common to all of the roads in that territory.


Photo by International

From Left to Right: F. P. Walsh, B. M. Jewell and W. Jett Lauck

He presented a memorandum and statistical exhibits showing the reductions in wages in other industries and in the cost of living which have occurred since the present railway wage scales were fixed by the Board in July, 1920.

Mr. Walber showed by bulletins issued by the Bureau of Labor Statistics of the United States Department of Labor dealing with wage rates in a dozen important branches of industry, that very substantial reductions of pay were made in these industries in the period from January to March, 1921. The statistics cited, Mr. Walber pointed out, "indicate a general and widespread reduction in wages from 10 to 30 per cent—the majority of reductions are 15 per cent or over."

Mr. Walber also submitted statistics regarding the reductions in the cost of living, based upon compilations made by various commercial agencies and also by the Bureau of Labor Statistics and the National Industrial Conference Board.

"The latest figures available from the Department of Labor," he said, "are for the period ending December, 1920, while the National Industrial Conference Board has compiled its figures to March, 1921. By reference to the declines from the peak (July, 1920, when the present wages were fixed) to December, 1920, as shown by these tables, it will be observed that the Department of Labor Statistics indicate a decline in the cost of living of 7.4 per cent, and the figures of the National Industrial Conference Board a decline of 7.1 per cent. The decline to March, 1921, according to figures of the National Industrial Conference Board, is 17 per cent, and if the Department of Labor figures for March, 1921, were available it is reasonable to assume that the similarity in the results obtained by both organizations would have continued."

In substance, the exhibits filed by Mr. Walber showed that when the present railway wages were fixed in July, 1920, the cost of living was 104.50 per cent more than it was in 1914, while in March, 1921, it was only about 67 per cent more than in 1914, and is still declining. These exhibits also indicated that the average railway wage per annum is now about 133 per cent more than it was in 1914.

Individual Carriers Present Their Cases

Following the presentation of these two general statements, the individual carriers began the submission of volumes of statistical analysis, charts and data relating largely to decreases in the cost of living and the wages being paid by outside industries for both skilled and unskilled labor at various points and comparisons between this data and respectively the increases which have taken place in the wages of railway employees and the present scale of railroad wages.

One of the first large roads to present its case was the Pennsylvania whose statement and brief to the Board said in part:

We desire to call particular attention to the studies made of wages paid in outside industries marked Exhibit No. 8 which is the result of a study of 1,235 plants and covers over 155,000 employees, or approximately three times as many employees as in these trades on the Pennsylvania. This exhibit clearly shows that the preponderating rates paid in outside industries are generally below those proposed in the carriers' submission and, in addition, it is shown that there have been further reductions since the information was first obtained.

The exhibit referred to in the preceding paragraph shows that in comparison with the prevailing rate of 85 cents an hour now being paid by the Pennsylvania to shop employees and 62 cents an hour to helpers, the weighted average rates of pay in 1,235 outside industries for similar work are as follows:

Number of men	Occupation	Weighted average rate per hour
51,586	Machinists	64.7 cents
4,536	Blacksmiths	66.1 cents
10.271	Boilermakers	64.3 cents
7,364	Sheet metal workers	65.8 cents
6,296	Electrical workers No. 1	60.9 cents
3,247	Electrical workers No. 2	61.9 cents
23,198	Carmen	60.9 cents
10,870	Moulders	70.0 cents
38,138	Helpers	49.4 cents

New Members of the Labor Board

President Harding on April 16 sent to the Senate his nominations for three appointments on the Railroad Labor Board to succeed the three members whose terms expired on April 15. The new appointees are Ben W. Hooper, former governor of Tennessee, as a member of the public group succeeding Henry T. Hunt; Samuel Higgins, former general manager of the New York, New Haven & Hartford, and more recently vice-president of the Vapor Car Heating Company, to succeed W. L. Park of the railroad group, and W. L. McMenimen, deputy president of the Brotherhood of Railroad Trainmen, to succeed J. J. Forrester of the labor group.

A Freight Train moving before daylight! Just think of it! A press dispatch from Winnipeg reports Canadian wheat and flour, sold to American dealers, as being "rushed across the border" to avoid the heavy duty that would be imposed should the Fordney tariff bill become law. "A special Canadian National train crossed the line before daylight today, carrying scattered shipments."

The Advantages of the Exhaust Steam Injector

A Considerable Saving in Fuel Is Effected by This Device, Which Is Extensively Used in Foreign Countries

BY CLARENCE ROBERTS

THE exhaust steam injector is used for boiler feeding on a great many locomotives in England and the British colonies, and to some extent in France. In England and the British colonies there are about 4,000 in use, and it is claimed in England the device effects an average saving in fuel consumption of 10 per cent.

The writer has ridden on English and French locomotives running on railroads in France equipped with exhaust steam injectors, and it was observed they were operated with the same facility as the live steam injector, evidently giving no more trouble than the latter. The engine crews seemed to like and take an interest in them, operating them on all occasions practicable in preference to live steam injectors, a fact that argues well for it. Operating officials spoke favorably of this type of injector and said that their operation was quite as simple as the live steam injector and maintenance costs were little or no greater. A motive power official of the Northern Railway (France) said his road a few years ago built some very heavy 4-6-4 type suburban locomotives which were over-cylindered and consequently bad steamers. They were afterward equipped with exhaust steam injectors which so improved their steaming performance that they made too much steam even after enlarging the exhaust nozzle openings.

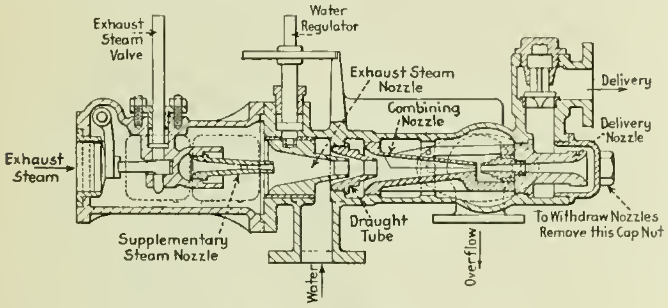


Fig. 1—Exhaust Injector and Valve

The exhaust steam injector was invented in England about the year 1876 and the early types when working with steam at atmospheric pressure were capable of feeding against boiler pressures up to 70 lb. per square inch. Since its invention it has been improved so that now it is as reliable as the modern live steam injector for locomotive boiler feeding. The latest types present several new and important features and represent a very great advance over all previous types. They restart automatically and when working with exhaust steam at atmospheric pressure are capable of delivering against a pressure of 120 lb. per square inch. With the addition of a small supplementary live steam jet the exhaust injector can feed against pressures up to 300 lb. per square inch. An auxiliary steam nozzle is provided for use when the locomotive is not using steam.

Principle of Operation

Few persons in this country have ever heard of the exhaust steam injector. To those who have read of it, it seems more or less of a mystery and contrary to all accepted principles that exhaust steam at atmospheric pressure should be able to force about ten times its own weight of water into a boiler under pressure. This seeming paradox, however, is easily explained when the action of the exhaust steam on the water is considered, for the same principles are involved as with the live steam injector, that is, a jet of steam moving at high velocity is condensed by a body of water moving at a low velocity; the momentum of the steam jet being transferred to the water, producing a combined jet moving with a resultant velocity sufficient to overcome the boiler pressure. While exhaust steam at atmospheric pressure has no velocity relative to the atmosphere, yet if it is allowed to issue into a vacuum, it has a very high velocity; the velocity of exhaust steam at atmospheric pressure flowing into a perfect vacuum is more than 2,000 ft. per second.

It is well known that when steam is condensed a vacuum is created, the degree of which is dependent upon the temperature of the water of condensation. In the exhaust steam injector a very high degree of vacuum is obtained by the condensation of the exhaust steam by the feed water in the combining nozzle of the injector. The highest vacuum is at the point of the steam nozzle where the steam and water meet. A vacuum of 24 to 26 in. of mercury is obtained, so that the exhaust steam flows in at an exceedingly high velocity. It there meets the feed water, and being condensed by it, gives up its momentum to the combined jet, which then flows along the combining nozzle where complete condensation takes place. The jet leaves the end of the combining nozzle at a velocity which is sufficiently high to carry it forward through the delivery nozzle and into the boiler. It will thus be seen the working of the injector is not dependent on steam being supplied under pressure as is so often supposed, the sole determining factor being the steam velocity.

A sectional view of the double jet type injector is shown in Fig. 1. This comprises a casing containing the various nozzles and also branches for the delivery, overflow and water pipes. The nozzles consist of the exhaust steam nozzle, draft tube, combining or flap nozzle and delivery nozzle, while in the exhaust valve casing is fixed the supplementary steam nozzle which projects into the exhaust steam nozzle. The exhaust steam entering the injector passes into the main central exhaust steam nozzle, at the mouth of which it meets the feed water. Condensation immediately takes place, a very high degree of vacuum being formed, and the combined jet flows forward at a high velocity through the draft tube into the combining nozzle. The region of high vacuum extends to the entrance of the combining nozzle, and at this point a second supply of exhaust steam is admitted, which, flowing

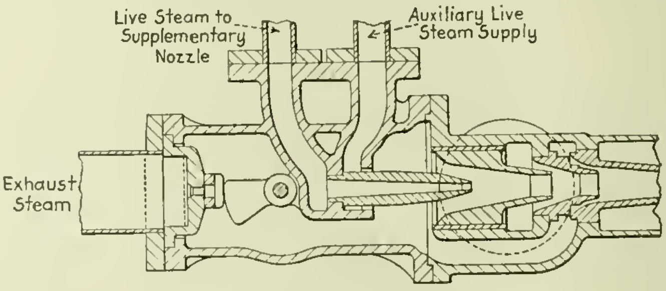


Fig. 2—Automatic Exhaust Valve

in at a very high velocity, impinges on and is condensed by the combined jet, imparting to it a further supply of energy, so increasing its velocity. After passing through the combining nozzle, the jet enters the delivery nozzle, where its velocity is reduced, the kinetic energy being changed into pressure energy, and leaving the injector, the water passes into the boiler. This type differs from the live steam injector in having a steam inlet nozzle of a much larger cross sectional area than that of a live steam injector of similar capacity, this being necessary to provide for the large volume of exhaust steam which must be passed.

An enlarged sectional view of the automatic exhaust valve is shown in Fig. 2. This governs the supply of exhaust steam to the injector, acts as a check valve when operating the injector with auxiliary steam when the engine is standing or running with steam shut off, and enables it to start automatically if the jet is in any way broken. As before stated, the exhaust steam alone develops a pressure of 120 lb. and for higher pressures a small jet of live steam is introduced through the supplementary nozzle. The steam supply for this nozzle is obtained through the passage of the exhaust valve casing shown in Fig. 2, from a pipe connected to a supplementary steam valve on the boiler. The small jet of steam introduced through this nozzle gives the additional pressure required to feed the boiler. Water regulation is effected by varying the area for the entrance of water into the nozzles, by moving the exhaust steam nozzle to and fro, so that the surrounding area between the end of the exhaust nozzle and the draft tube is varied, and consequently the quantity of water entering is regulated according to the amount required. When necessary to work the injector as a live steam injector (when the locomotive is not using steam), a supply of live steam is introduced into the automatic exhaust valve casing through the auxiliary steam branch, entering the injector at the annular nozzle surrounding the supplementary nozzle. This supply flows into the exhaust steam nozzles, replacing the exhaust steam, and the injector works exactly as when exhaust steam is used, being as reliable and simple an instrument as any live steam injector, and equally prompt in starting and certain in action.

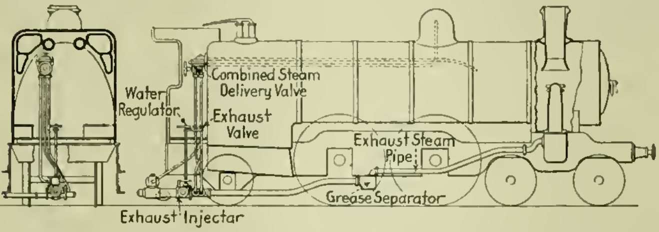


Fig. 3—Arrangement of the Exhaust Injector on the Locomotive

The exhaust steam injector is capable of delivering against pressures as shown on the following table:

Exhaust Steam Pressure Lb. per square inch	Delivery Pressure Lb. per square inch
1	120
5	150
10	180
15	210
Atmospheric pressure augmented by small jet of live steam from supplementary nozzle	300

In Fig. 3 is shown the method of applying this apparatus on a British type of locomotive. This is diagrammatic only and can be modified to meet the requirements of design of any type of locomotive. A grease trap is necessary in the exhaust pipe. The size of injector known as No. 13, having a 4½ in. exhaust pipe and 2¼ in. delivery pipe, has a capacity of 3,800 gallons of water per hour using exhaust steam in connection with the supplementary jet.

In their efforts to increase the operating capacity and efficiency of the steam locomotive in America railroad men seem to have overlooked or not realized the importance of the exhaust steam injector as a heat saving appliance, for it should not only prove decidedly more efficient than the live steam injector, but everything considered should be comparable with the feed water heater in point of economy.

For boiler feeding the injector has practically one hundred per cent thermal efficiency and its first cost and cost of maintenance is less than a boiler feed pump, though the live steam injector is not the most economical means for feeding a boiler if waste or exhaust steam is available and can be utilized for heating the feed water, but we must not lose sight of the fact that in feed water heating economy comes only from utilizing heat that is now going to waste for it cannot be considered a saving to utilize the exhaust steam from an appliance that replaces the injector for boiler feeding.

The advantages that should be derived from the use of the exhaust steam injector may be briefly stated as follows:

(a) Low first cost and low maintenance costs.
(b) Low rate of depreciation.
(c) Simplicity of design and ease of operation.
(d) The utilizing of exhaust steam for feed water heating which results in saving both water and steam and consequently fuel.
(e) Reduction in back pressure in the locomotive cylinders.

There should be a field for the exhaust steam injector in America. In England an average fuel saving of 10 per cent is claimed for the exhaust steam injector, and with our relatively higher back pressures we should obtain even a greater saving, so that the net saving in money probably would be as great or possibly greater than with feed waterheaters for which a 15 per cent saving is claimed.

The Rusting of Steel Containing Copper

It is generally believed that iron containing copper in amounts of small fractions of one per cent is less liable to rust than iron free from copper. To investigate this problem, comprehensive tests extending over six years were started in 1913 by Professor Bauer for German iron works. These works sent Thomas and Siemens and other steel in large sheets to be tested both with the scale on and after the scale had been removed. The steel contained about 0.1 per cent carbon, 0.5 per cent manganese and phosphorus and sulphur up to 0.09 per cent, nickel up to 0.2 per cent and chromium 0.04 per cent maximum. Copper was added in percentages up to 0.35. The weighed sheets were exposed to various atmospheres and liquids and the rust was removed and weighed.

The specimens were exposed for over four years in good country air, but the influence of the copper content on the rapidity of rusting was not noticeable. In the salt spray near the ocean, the rusting was more marked, but again the copper made no difference. In the impure air of an iron district, however, the effective influence of the copper was perceptible. In all cases the nickel in the steel also seemed to prevent rusting. Sheets were buried in slag sand and the corrosion of the steel indicated that the influence of the copper was to protect the Siemens steel and to hasten the corrosion of the other steel.

Summing up the tests, it would appear that in the presence of relatively high percentages of carbon dioxide and of sulphur dioxide, a slight percentage of copper and of nickel as well, seemed to retard the rusting of steel.

Electrolytic tests were conducted with a specimen suspended in dilute sulphuric acid and it was found the steel suffered less corrosion under these circumstances when a small percentage of copper was present than in the absence of copper. This was particularly marked in the case of steel relatively high in phosphorus. The copper seemed to counteract the evil effects of the phosphorus. Even in these tests the anti-corrosive effect of the copper on the steel was not strong, however.

The Cost of Boiler Scale

BY W. F. SCHAPHORST

No one disputes the statement that scale is a bad thing, that it has caused and is causing serious losses. The actual money loss due to a definite thickness of scale is a variable quantity, for much depends upon the kind of scale, whether carbonate or sulphate, hard or soft, etc.

The most commonly used rule for determining the money loss is that given in Sames' Mechanical Engineering Handbook as follows: "Scale of 1/16 in. thickness will reduce boiler efficiency ⅛; and the reduction of efficiency increases as the square of the thickness of scale."

The chart shown herewith is based upon the above rule.

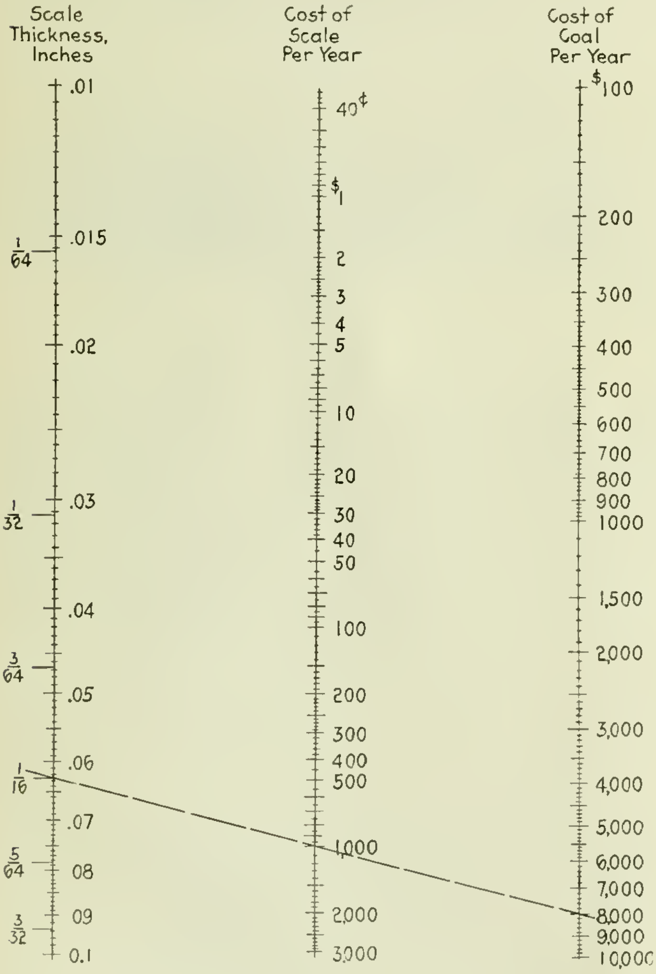


Chart for Determining Loss Due to Scale

It covers all scale thicknesses from .01 in. to 0.1 in. and for convenience shows thicknesses in fractions as well as in decimals of an inch. The dotted line indicates that where $8,000 is spent per year for coal, $1,000 per year is lost due to a scale 1/16 in. thick.

Whatever the thickness of scale and whatever the coal costs per year (up to $10,000), this chart shows the money loss in strict accordance with the given rule. It may help to indicate where the installation of a water treating device would save money or it may show how often boilers should be thoroughly cleaned.

Comparison of Steam and Electric Locomotives

At a meeting of the Franklin Institute held at Philadelphia on April 14 two papers were read on steam and electric motive power. The characteristics of the electric locomotives were discussed by N. W. Storer, general engineer of the Westinghouse Electric & Manufacturing Company, while the characteristics of the steam locomotive were treated by A. W. Gibbs, chief mechanical engineer of the Pennsylvania System.

Mr. Storer stated that he considered it probable that there would gradually be a radical evolution of operating methods in order to utilize the electric locomotive most effectively and discussed some of the factors to be considered in this connection. An important advantage would result from making the speed of passenger and freight trains more nearly uniform, as could be done advantageously with electric motive power. On account of its greater reliability the electric locomotive would not impose the same limitations on the length of operating division as the steam locomotive and greater mileage could be obtained from the individual units. Under certain conditions the use of aerial right over track was of great importance. Electrification opens up possibilities in the use of multiple level stations to increase station capacity and improves the operation of stub-end stations by decreasing the number of switching movements. In concluding, Mr. Storer discussed at some length the relative advantages of various types of motors and compared the speed-pull curves with those of typical steam locomotives.

Mr. Gibbs confined his remarks to the mechanical problem of transmitting power from the motors to the wheels and the behavior of locomotives as vehicles. He stated that while the transmission of power in electric locomotives seems simple it really is very difficult and while the electrical features of the motive power were often satisfactory, the mechanical features were troublesome. After discussing briefly the various types of transmission, Mr. Gibbs outlined some of the difficulties encountered in designing locomotives for high speed. In developing the design of Pennsylvania electric passenger locomotives, tests were conducted to determine the riding qualities of electric engines with various wheel arrangements. A section of track was prepared especially for measuring the stresses, a record being obtained by the impression of a steel ball on a steel plate inserted in special ties. The tests showed that a high center of gravity was advantageous and that symmetrical driving wheel arrangements were unstable. Some of the electric engines proved very destructive to the track and as a result of these tests, a design of locomotive with wheel arrangements corresponding to two eight-wheel engines facing in opposite directions and with motors above the wheels was adopted. In conclusion, Mr. Gibbs stated that there was still much to learn with regard to the behavior of electric locomotives as vehicles and further tests should be made to determine the most satisfactory types.

Production of soft coal in the week ended April 16 was marked by a slight but distinct recovery, says the weekly bulletin of the Geological survey. The output is estimated at 6,525,000 net tons, an increase of 416,000 tons over the week preceding and the largest since the second week of March. For several months the output of the mines has been very low.

Since the Period immediately preceding the war, the number of freight cars on the Italian railways increased from 90,000 to 120,000, while the number of locomotives in the same period fell from 4,400 to 4,200. This diminution accompanied an increase in the length of line operated amounting to 900 miles. Locomotives have not yet recovered from the hard usage undergone in meeting war demands. Proper repairs and the building of new locomotives were slighted during hostilities, and since the cessation of hostilities various dislocations and labor conditions have interfered with construction work in this line.—*Commerce Reports.*

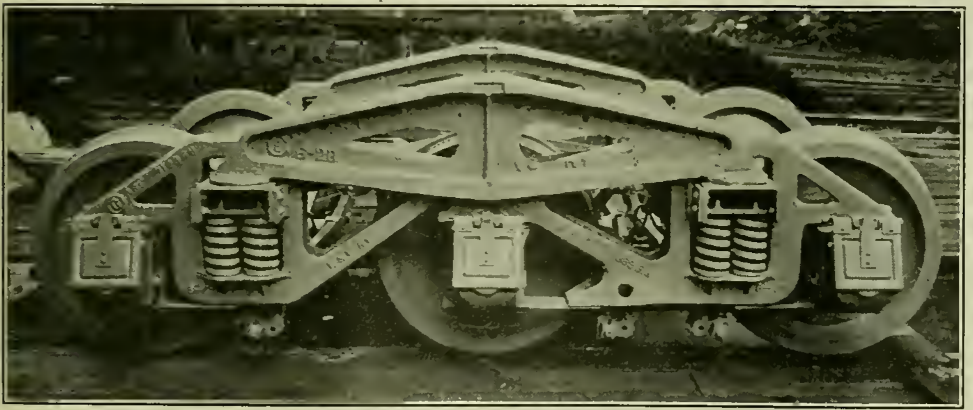
New Norfolk & Western 100-Ton Coal Cars

Body Supported on Side Bearings Instead of Center Plate—New Type Six-Wheel Truck

BY JOHN A. PILCHER

Mechanical Engineer, Norfolk & Western

THE lightest car for its load carrying capacity ever built for heavy train service is illustrated in the accompanying drawings and photographs. An order of 500 of these cars is now nearing completion at the Roanoke shops of the Norfolk & Western, under the supervision of A. Kearney, superintendent of motive power. The advantages of a car of such light weight can be judged from an estimate of the cost of operation prepared in connection with this design. It has been computed that if all these cars could be kept running at the same rate that the first one operated for the first three months, (about 90 miles per day), the additional earnings over those of the previous large capacity cars built by the Norfolk & Western, would pay for them in five years. This accomplishment is due in part to the light weight of the trucks and body and in part to the larger cubic capacity.



Side View of the New Type Truck, Which Carries the Load on the Side Bearings

The special feature of the design is the truck which carries the load on the side bearings instead of on the center plate. This arrangement not only gives perfect equalization of loads between the wheels at all times, but reduces the oscillation of the car to a minimum and contributes very materially to the lightness of both body and trucks. The average weight of car and lading is very near 253,500 lb.; the A.R.A. limit for a six-wheel car with 5½ in. by 10 in. journals. The general dimensions and weights of the car are shown in the tabulation. The equipment applied to this order includes wrought steel wheels, Miner friction draft gear, type A-18-S, with Farlow single key horizontal yoke draft attachments. Four hundred of the cars are equipped with Westinghouse K-2 triple valves and 100 with the Automatic Straight Air brake. The brake rigging has one brake beam per axle. The hand brake, arranged with a quick take-up, is geared to give braking power equivalent to the air brake.

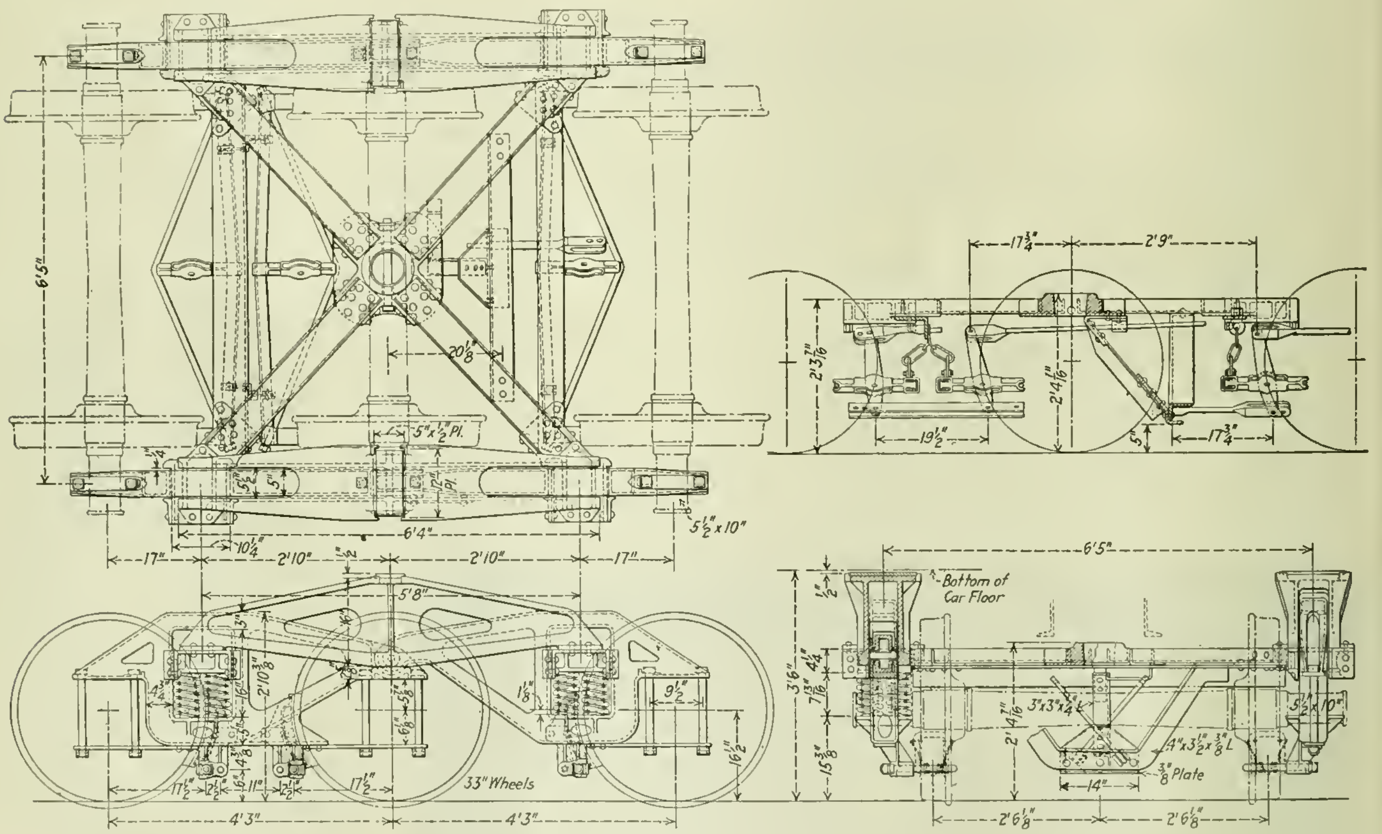
The truck is of the three-axle, articulated type, mainly of cast steel, with two side frames on each side, secured together over the center boxes. The boxes used are the regular A.R.A. standard, although the design lends itself readily to the use of the semi-pedestal type of box, now in very general use. It is the lightest six-wheel truck of this capacity ever built. The pair of trucks weighs 24,480 lb.

The springs are so located in the frames as to give equal load distribution on the wheels when equal loads are applied to each group of springs.

Beams made to straddle the frames reach from one group of springs to the other, on each side of the truck, and support the weight of the car at their centers. This gives an equal load on each group of springs. The beams rest upon, and are secured to spring caps tying them together lengthwise of the truck, and are themselves side members of a rectangular, cross-braced centering spider, which serves to hold the two sides of the truck together and in proper relationship. The truck is thus held square. The cross bracing holds the guide for the centering pin on the car body. The keepers, riveted to the outside of the spring caps, and the projecting lugs cast on them, coming inside the side frames, are the guides to hold the frames together and apart. The carrying beams, straddling the frames, are riveted to the top of the spring caps and serve in a like capacity.

Principal Dimensions and Weights of Norfolk & Western 100-Ton Coal Car

Length over striking plates	43 ft. 9 in.
Coupled length	46 ft. 2 in.
Truck centers	31 ft. 8 in.
Truck wheel base	8 ft. 6 in.
Height from rail to top of car side	11 ft. 0 in.
Height of center of gravity (loaded with 200,000 lb.)	81 in.
Inside length	42 ft. 7 in.
Inside width	9 ft. 6 in.
Outside width	10 ft. 1¼ in.
Cubical capacity—level full	3,122.5 cu. ft.
Cubical capacity—30 deg. heap	513.5 cu. ft.
Cubical capacity—including heap	3,636 cu. ft.
Revenue load	200,000 lb.
Weight of car body	29,020 lb.
Weight of two trucks	24,480 lb.
Weight of empty car	53,500 lb.
Total weight, loaded with 200,000 lb	253,500 lb.
Per cent revenue load of total weight	78.88 per cent.
Weight per foot coupled length	5,491 lb.
Weight of one truck	12,240 lb.
Rail load per pair of wheels	42,250 lb.
Density of load of 200,000 lb	55 lb. per cu. ft.



General Arrangement of the Six-Wheel Truck

The design, which is light in weight, readily gives the strength to resist forces in any horizontal direction. One of the cross-tie members is made of an angle to give it stiffness and permit the attachment of the dead end of one of the brake levers. A cable guard, to protect the brake beams from the cable used in hauling the cars up to the dumper, is attached to the under side of the diagonal braces, and is itself braced back to the center, so that it can serve as a fulcrum for the dead end of one of the brake levers.

The brake is arranged, one beam per axle, using No. 2 beams. The pull from the cylinder rods comes to two of the brake levers set on opposite sides of the truck, eliminating any turning movement on the truck. The separation of the brake lever system on the truck into two parts gives independent adjustment for brake shoe and wheel wear, and prevents accumulating lever angularity. All of the adjusting points are readily accessible. The truck is open and can be easily inspected from alongside the car. Since there is a possibility of low or soft spots in the track, the four points on the truck sides, upon which the four groups of springs rest, cannot always be kept in the same plane. The structure resting on the springs must, therefore, be either vertically strong enough to resist the differences in reaction at the four corners, produced by the differences in spring tension, in case any one of the spring seats leaves the normal plane, or it must be vertically flexible enough for any corner to follow the spring seat out of the normal plane, without having set up within it destructive stresses.

This rectangular cross-braced centering spider has been designed to meet these conditions. It was carefully proof tested in the following manner:

It was rigidly fastened to a stiff frame at the three corners, *A*, *B* and *C*, shown in the diagram of the spider, while the fourth corner, *D*, was attached to the plunger of a rail gaging machine having a stroke of 1½ in. This allowed the alternate lowering and raising of this corner below and above the normal plane. A counter on the machine recorded the number of movements up and down—each number on the counter representing a stroke up and a stroke down. A Berry Strain Gage, with points eight inches apart, was placed at the points on the diagram numbered 1, 2, 3, 4 and 5. Readings were recorded at corresponding points on the diagonals leading to the four corners at about the time the counter showed 2,212, and again when it showed 81,868. After this a change was made and the plunger of the gaging machine was attached to the corner marked *A*, the corners marked *B*, *C* and *D* being held rigidly in a plane. The counting was begun over. The readings of the Berry Strain Gage were taken on each diagonal when the counter registered about 6,155, and again when it indicated 99,138. It is to be noted from the table that differences in reading before and after the large number of movements is insignificant, showing no sign of deterioration. The highest unit strain in inches recorded is .00046, which, when using 27,000,000 as the modulus of elasticity, represents a fiber stress of 12,240 lb. per sq. in. Measurements were made to determine the forces applied at one corner to produce the movements ¾ in. above and ¾ in. below the plane of the other three corners of the centering spider. At the bottom of the table are given the results, which show that only a relatively small differential in loading at the corners will overcome the vertical stiffness of the centering spider.

FLEXIBLE TEST OF T-33 TRUCK BOLSTER

Unit strain in inches

		Location 1			Location 2			Location 3			Location 4			Location 5		
No of vibration cycles	Arm	Up or compression	Down or tension	Total movement up and down	Up or compression	Down or tension	Total movement up and down	Up or compression	Down or tension	Total movement up and down	Up or compression	Down or tension	Total movement up and down	Up or compression	Down or tension	Total movement up and down
Machine Attached at Arm D 4-10-20 to 4-19-20																
2,212	D	.00045	.00035	.00080	.00041	.00037	.00078	.00032	.00027	.00059	.00024	.00022	.00046	.00014	.00014	.00028
81,868	D	.00035	.00047	.00082	.00039	.00037	.00076	.00032	.00030	.00062	.00025	.00026	.00051	.00016	.00019	.00035
2,212	B	.00046	.00039	.00085	.00038	.00039	.00077	.00036	.00025	.00061	.00022	.00020	.00042	.00011	.00011	.00022
81,868	B	.00042	.00044	.00086	.00039	.00035	.00074	.00029	.00029	.00058	.00020	.00022	.00042	.00012	.00011	.00023
2,212	C	.00027	.00022	.00049	.00025	.00027	.00052	.00020	.00019	.00039	.00007	.00008	.00015	.00002	.00002	.00004
81,868	C	.00026	.00022	.00048	.00025	.00025	.00050	.00015	.00017	.00032	.00007	.00007	.00014	.00002	.00002	.00004
2,212	A	.00032	.00031	.00063	,00035	.00032	.00067	.00023	.00022	.00045	.00014	.00014	.00028	.00001	.00003	.00004
81,868	A	.00031	.00027	.00058	.00029	.00035	.00064	.00022	.00023	.00045	.00014	.00015	.00029	.00003	.00005	.00008
Machine Attached at Arm A 4-19-20 to 4-27-20																
6,155	B	.00028	.00032	.00060	.00032	.00031	.00063	.00025	.00021	.00046	.00017	.00015	.00032	.00010	.00009	.00019
99,138	B	.00037	.00026	.00063	.00032	.00029	.00061	.00024	.00022	.00046	.00018	.00014	.00032	.00009	.00006	.00015
6,155	D	.00032	.00033	.00065	.00029	.00030	.00059	.00024	.00020	.00044	.00015	.00015	.00030	.00001	.00001	.00002
99,138	D	.00035	.00028	.00063	.00030	.00028	.00058	.00024	.00020	.00044	.00015	.00014	.00030	.00002	.00005	.00007
6,155	C	.00032	.00031	.00063	.00035	.00034	.00069	.00027	.00026	.00053	.00019	.00017	.00036	.00007	.00007	.00014
99,138	C	.00034	.00028	.00062	.00034	.00031	.00065	.00026	.00025	.00051	.00021	.00015	.00036	.00008	.00006	.00014
6,155	A	.00032	.00032	.00064	.00037	.00039	.00076	.00035	.00025	.00060	.00025	.00022	.00047	.00015	.00014	.00029
99,138	A	.00030	.00036	.00066	.00044	.00032	.00076	.00031	.00030	.00061	.00028	.00021	.00049	.00017	.00015	.00032

Machine Attached to Arm D

Force exerted in compression	808 lb.
Force exerted in tension	522 lb.
Total	1,330 lb.

Machine Attached to Arm A

Force exerted in compression	516 lb.
Force exerted in tension	613 lb.
Total	1,129 lb.

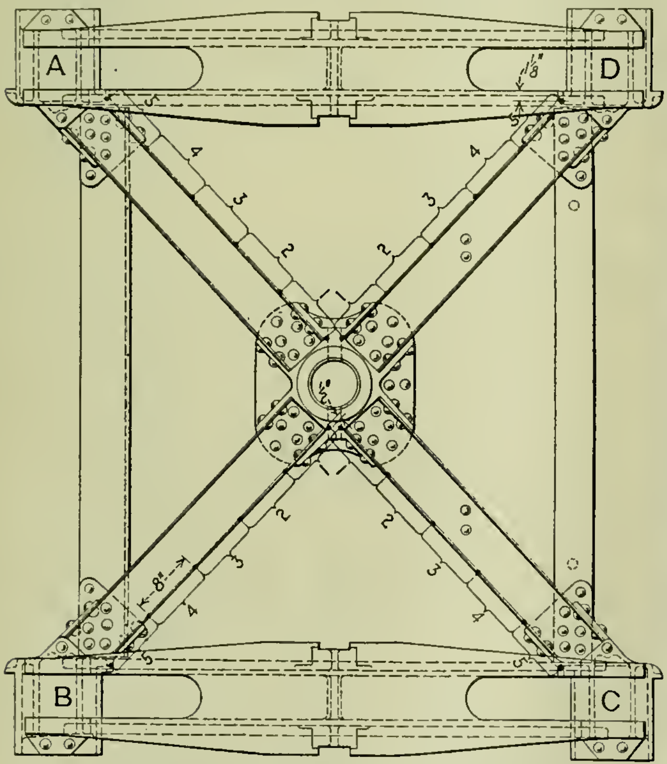
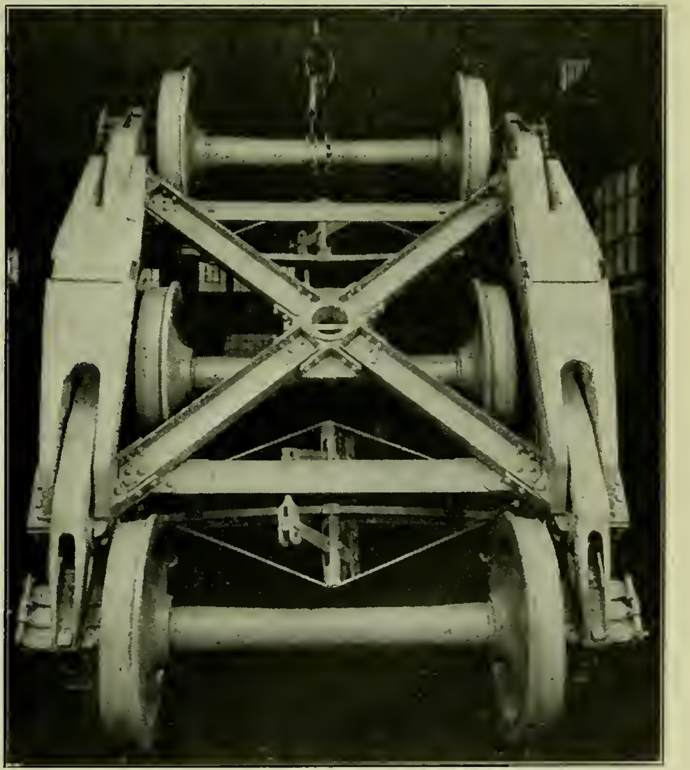


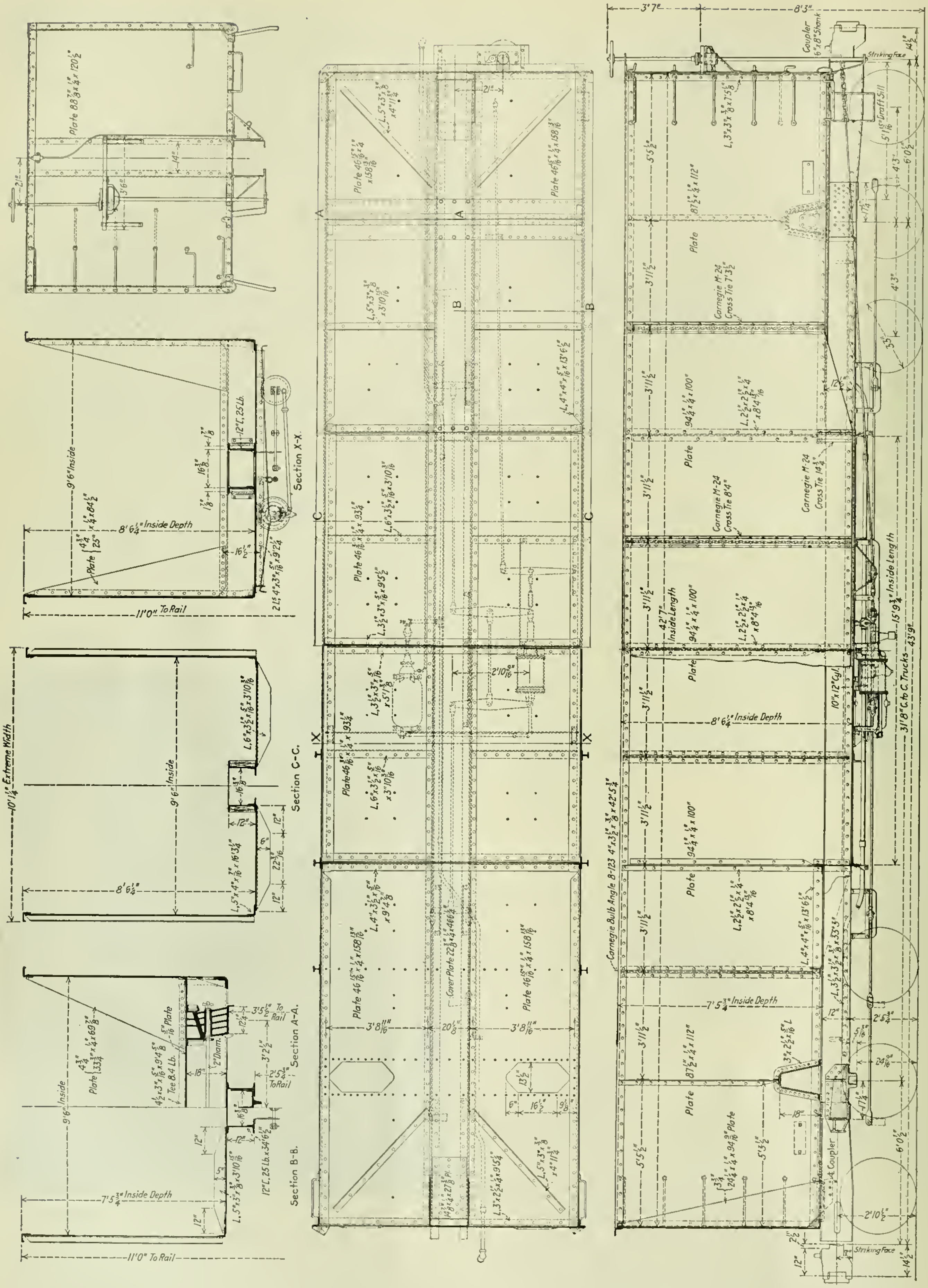
Diagram of Test of Flexibility of Truck Bolster

The Car Body

The use of the side bearings, placed over the center of the truck side frames for load carrying, obviates the necessity for the strong, heavy bolster members from side to side of truck, supporting the load at its center. This not only decreases

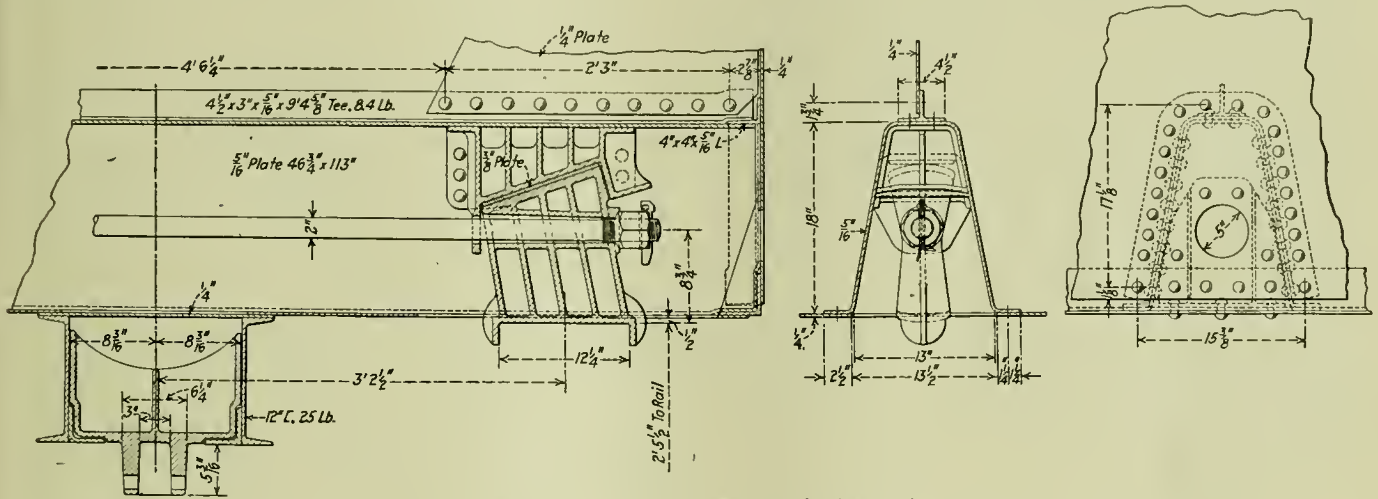


A View of the Truck from Above, Showing the Centering Spider and Beams Spanning the Side Frames



Plain, Side and End Elevations and Sections of the Car Body the weight of the truck, but also decreases the weight of the the body bolster show the location and details of the load-carry the load from the car side all the way to the center, but only for the very much shorter distance to the points over the truck side frames.

The general drawing of the car and the arrangement of the body bolster show the location and details of the load-carrying conical rollers. Only enough of the middle section of the conical roller is used to provide sufficient lateral movement at the roller for the car to negotiate a 35-degree curve. The bottom of the roller is limited in its lateral movement by the sides of the opening in the bottom of the car, through which the roller projects. The body bolster is made hollow to allow room for the roller. The bottom face of the roller is set in a horizontal plane, normal to lines of load forces, in order that there may be no horizontal components tending to displace the load-carrying side beams on the truck. The projections on the bottom side of the roller at each end serve as guides for proper placing. Normally, these projections should not come into action for holding the bottom of the roller in place on the truck side beam, as there are no normal forces tending to displace it. The upper sides of the conical rollers incline toward the center. The lateral component of reaction against the inclined surface on the roller seat is taken up by compression in the body bolster and tension in the rod tying the two opposite rollers together. In case anything should happen to this rod, these reactions will all be within the roller seat itself. The outside end of the roller seat is made of sufficient strength to take care of these forces if the occasion arises.



Arrangement of Body Bolster and Conical Roller

The tie rod passing through a slotted hole in the inside projecting lug on the seat serves to hold the rollers in place in case the car is jacked off the trucks. The roller is guided, on its top side, by the pocket in the seat. It is cast of high carbon steel, and bears against hardened-steel plates, top and bottom. It is made long and of large diameter, reducing to a minimum the probability of flattening the contact surfaces during any reasonable period of service.

The use of conical rollers of large size makes this approximately an anti-friction bearing, and reduces to a minimum the forces needed to rotate the truck under the car. Any slight flattening of the contact surfaces that might occur after a long period of service would only very slightly increase the forces needed for the turning. Even if after years of service the surfaces should flatten to an objectionable extent, the renewal of rollers and seats is a simple and comparatively inexpensive operation.

The roller seat at its top side conforms to the shape of the inside of the bolster plates and distributes the load over a large portion of the surface, requiring very little riveting to hold it. The holes in the sides of the car are used for entering and securing the tie rod connecting the rollers. They are reinforced on the inside of the side plates with bracket castings and furnish a place for a special hook provided with the wrecking outfits, for lifting the car body in any emergency. Some such arrangement is necessary since the use of ordinary hooks indiscriminately at any point on the loaded car would give such heavy concentration of loading as to tear and mutilate the car body.

A tee is used to increase the section of the top flange of the bolster girder, and its top extending web serves for the attachment of the bolster gusset plate. This gusset plate connection with the side of the car, together with the beaded angle at each end of the bolster, connecting the bolster web plates with the car side, transfers the load coming from the car side through the body bolster to the roller seat, without undue concentration at any point. The car body bolster is placed above the car floor line so as to give room under the car for the supporting beam on the truck over the center box and truck side frames. This allows reasonable depth and economy in the design of the beam.

On a hopper car the hollow bent plate bolster can be placed in the same relative position to the truck without being placed above the inclined floor of the car. The centering casting on the car body is integral with the draft gear back stop. The holes receiving the pin fastening together the body and truck center castings, are slotted in order to allow the necessary angular movement between truck and car. There is no normal vertical movement between these two parts.

The center portion of the car, between trucks, has the bottom placed on a line with the bottom of the center sills, thus gaining additional cubic capacity, and slightly lowering the center of gravity.

The cross diaphragms in the car framing become the ends of the depressed bottom. On the outside of the car, short pieces of tie section, the same as the side stakes, are placed so as to come opposite the cross diaphragms and bear against the car dumper blocking, supporting the car at a strong point of reaction. The side stakes and top coping angles serve the same purpose.

The vertical corner angles connecting the side plates of the car with the end plates have the flanges, attached to the end plates, turned out, so that the projecting edge of this flange, together with the edge of the plate riveted to it, will bear against the dumper blocking, thereby helping support the weight of the car and lading and protecting the grab irons from injury. Both the corner push-pole pocket and reinforcing bracket casting, under the center of the body bolsters, furnish placed for jacking and stooling the car.

The general details of construction can be understood from the drawings.

(This article will be concluded in the June issue.)

Annual Report of the Bureau of Explosives

Much interesting data on the handling of hazardous commodities is contained in the annual report of the chief inspector of the Bureau for the Safe Transportation of Explosives and Other Dangerous Articles for the year 1920, which has just been issued. To one unfamiliar with transportation conditions, it would naturally seem that the shipments that would cause the greatest damage would be those containing high explosives. It is interesting to note that the loss per ton for nitric acid and "strike anywhere" matches is considerably greater than for either high explosives or black powder. The greatest losses from any single commodity are those resulting from the transportation of gasoline, due principally to the large volume of the shipments.

The actual total loss for the year 1920 amounted to $1,090,806 for all kinds of dangerous articles. This is a decrease of over half a million dollars compared with the previous year. Nevertheless, the report states that the majority of the 1,977 accidents resulting in this loss should not have happened, as they were due to carelessness or ignorance.

Particular interest attaches to the statistics regarding transportation of gasoline, as the losses due to these shipments are greater than from any other single commodity. The total loss from this cause has been decreasing in recent years. In 1918 it was $900,106; in 1919, $691,635, and in 1920, $351,262. During the past year, special attention has been given to the bottom discharge valve in tank cars, as this has been a prolific source of loss. A summary of accidents chargeable to this part of the tank car shows little or no improvement in the last two years.

A comparison that has not been made in previous reports is shown in a summary of reported losses compared with the total production for several important commodities. The statistics for 1920, which are typical, show that the loss per ton was as follows:

Nitric acid	$1.71
Matches	.51 2/10
Black powder	.19 9/10
Charcoal	.08 7/10
Gasoline	.02
High explosives	.00

In discussing the importance of education, the chief inspector mentioned the good results secured by the organization plan prepared by the bureau for the purpose of interesting and educating railway employees in the regulation, which has been adopted quite generally by the railroads.

The glass carboys in which acids are shipped are not sturdy containers and many accidents are caused by breakage of these vessels. Recently an attempt has been made to prescribe suitable tests for carboys, and this work is outlined in the report.

The review of tank car matters points out that the casualties in gasoline tank car fires were reduced in 1920 to no deaths and 6 injuries, as compared with 2 deaths and 28 injuries in 1919. A review of the work being carried on by the bureau in connection with the A. R. A. tank car committee and the American Petroleum Institute is given. This pertains particularly to improvements in the bottom outlet valve, the dome closure and the safety valve. Special mention is made of experiments now being conducted for the purpose of developing a standard specification for tank cars for muriatic acid.

The concluding section of the report is devoted to a discussion of the detailed work of the bureau. Numerous statistical summaries are given and circulars issued during the year are collected and reprinted.

Saving Money in Car Repairs*

BY A. F. O'BRIEN

Little or no attention has been given to the revenue derived or lost in repairs to freight cars or to the study that is required of the men who have undertaken the task of keeping equipment in safe and serviceable condition. The average railroad man knows practically nothing as to how repairs to cars are handled or how the company is reimbursed for its expenditure in connection with the repairs to foreign equipment, the amount of which involves millions of dollars each year.

The American Railway Association rules must be thoroughly understood by those in charge of the work, and particularly so by the inspector of A. R. A. repair cards, whose duty it is to make up the repair cards in order that each operation may be described in such a way that there can be no question as to the operations performed.

After the repair cards are made up they are passed to the billing department for pricing. The duties of the bill clerk pricing these repair cards are nerve racking. He must read thousands of repair cards made up by hundreds of employees and know just what operation each one is trying to describe. A wrong interpretation of the repair card may mean considerable loss of money to the company. The bills rendered against the company by foreign lines is an item that must be properly checked. The bill clerk should be a practical car man, who knows the construction of equipment, the knowledge of which can only be gained in actual experience in the shop. Such a man is an asset to the company and his value cannot be over-estimated. He can tell at a glance whether the operation described on the foreign line repair card could be performed on a car in any certain series and eliminate such charges as are improper.

The amount of money saved in a year through the elimination of such improper charges may be represented in no less than five figures and this is no doubt also true where small items, such as pin chain clevises, nuts, air hose and numerous other parts are used to repair foreign cars in train yards and on line between stations and not reported. If train crews would realize that every air hose applied on the line between stations on account of being burst and not reported is worth $2.30, which amount should be charged to the car owner, and every knuckle $4.80, knuckle lock $1.95, brake shoe $0.56, etc., there would be an immediate increase in the number of reports of material applied on the road turned in.

Another item that takes its yearly toll in dollars and cents is the improper handling of equipment in yards by switch crews. This is an item that in the majority of cases a little forethought on the part of the men handling the equipment would prevent. A slight rake or the cornering of a car may not seem much to look at, but the cost to repair when figured up, with the present high cost of labor and material, would indeed surprise those responsible.

MAKING BOLTS FIT TIGHT.—Two novel and interesting methods of making a tight fit in bolts subjected to shearing stresses are described in the report of the Bureau of Standards, abstracted in the *Iron Age.* The bureau was requested to devise a method by which bolts could be secured with a tight fit over the entire length Two methods were tried, both of which gave satisfactory results. In the first case the bolts were finished a little larger than the holes in the plate. They were then immersed in liquid air until they contracted sufficiently to enter the holes quite easily. Upon warming up, the bolts expanded, gripping the plates tightly In the second method, each bolt was provided with a small hole along its axis and was finished to an easy fit in the plate. After insertion, a charge of powder was exploded in the small hole. This expanded the bolt causing it to grip the plate. Subsequent physical tests indicated that the strength of the joint secured by both methods was sufficiently high for the purpose.

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*From the Erie Railroad Magazine.

Repair and Maintenance of Steel Freight Cars*

Necessity for Adequate Shop Facilities and Proper Organization Strongly Emphasized

BY SAMUEL LYNN
Master Car Builder, Pittsburgh & Lake Erie

HEAVIER motive power, with greatly increased train tonnage, has created a demand for cars of increased capacity. The limit of capacity apparently has not yet been reached, since one of the large car companies has, within the year, constructed cars of 120 tons capacity.

While no accurate figures are available, it is estimated that approximately 70 per cent of the two and one-half million freight cars in service in North America are either of all-steel, steel underframe or steel center construction. As this number of cars represents an investment of over three billions of dollars, the importance of keeping them in good repair and in service is self-evident.

Maintenance Badly Neglected

A casual inspection in almost any classification yard will reveal the fact that repairs to steel cars have been badly neglected during the past few years. Large numbers of cars may be seen with floor, hopper and side sheets badly corroded and in many cases rusted and worn entirely through. A close inspection will usually develop the fact that center sills are buckled either in front of, or between the body bolsters. This condition is due either to faulty construction, sills of insufficient area, abuse in service, or neglected maintenance. Conditions existing during the recent world war imposed many hardships upon the railroads generally, making it almost impossible for them to keep the maintenance of their freight equipment up to pre-war standards. Shortage of labor and materials, coupled with the pooling of equipment, had a tendency toward deferred maintenance, which resulted in merely patching up worn-out cars and keeping them in service long after they would have been shopped for rebuilding under a normal maintenance program. The large percentage of home cars on foreign roads resulted in neglect, since proper material for repairs of foreign cars was not generally carried in stock. This resulted in makeshift repairs, most roads doing only enough work on foreign equipment so that it would haul one more load, in the hope that it would carry that one load off the line and never return. The results of this practice are now most evident when cars are being returned to the home roads in large numbers and in almost universal bad order.

The speaker believes that the exterior of steel cars should be kept well painted, as by this process at least one side of the steel is protected against corrosion; in addition to this, well painted equipment is a good advertisement for any road. It is obviously impracticable to attempt painting the interior of open top steel cars, since the commodities usually carried in such cars consist of coal, coke, iron ore, limestone, furnace slag and mill products, which in the process of loading and unloading so badly damage the paint that it would serve no purpose as a protective coating. The interior of steel equipment is where corrosion is the most evident and is probably due to moisture laden with acids from the products of the mines and mills, or to electrolysis caused by impurities existing in the steel itself.

I would like to here state a few things that in my opinion are necessary to maintain steel car equipment properly and economically.

First: Shops should be provided at points where heavy repair steel car work is to be performed. They should be well lighted and ventilated, and in the colder sections of the country should be properly heated. Overhead crane service is desirable, and by proper arrangement eliminates the necessity for material tracks between the working tracks. Small wall or jib cranes should be installed for handling yoke riveters, etc. The money expended for shops will repay the investment many times over in a few years. While I would not say that a steel car cannot be repaired outside under adverse weather conditions, I believe that the work can be carried on more successfully where shops are provided.

Second: Shops should be well equipped with suitable machinery, properly located so that repair parts may be made economically without any lost motion or backward movement. It is a question whether or not it pays to attempt the manufacture of all steel car parts in the average railroad shop. Some of the larger railroads buy most of their car repair parts already punched and pressed into the proper shape ready for application. However, it is necessary to have sufficient machinery to make odd parts or to extend the supply when exhausted, as it is almost impossible to keep sufficient parts on hand to meet all conditions.

Punches, shears, hydraulic presses, heating furnaces, and a good supply of efficient pneumatic tools are indispensable in the modern shop and will soon repay the initial cost of installation. Sufficient compressor capacity with facilities for supplying dry air at all times is necessary for the economical use of pneumatic tools. Proper facilities should also be provided to take care of the scrap parts that will accumulate, and the shop and surroundings should be kept clean at all times. While this may not seem important to some, nevertheless it has a certain moral effect on the workman, which should not be underestimated.

Third: Other facilities must be provided, such as storehouses, storage yards, air brake shops, paint shops, oil houses, etc., depending on the size of the shops. The storehouse or material supply house should be located as near the shops as possible and electric tractor service or other means installed for convenient and economical transportation of materials. Fuel supplies and stores should be under direct supervision of the foremen in charge, or if the shop organization does not permit this, the storekeeper and car foreman should be very close together and work in perfect harmony.

The Importance of Supervision

Fourth: Another and probably one of the most important factors in repairs to steel cars is the quality and quantity of supervision. Sufficient intelligent supervision must be furnished or the work will lag and both the quality and quantity of the output will suffer. The gang foreman who comes into daily personal contact with every man under him is the keystone of any organization. He forms the contact point between the management and the men and when the contact is broken, the current ceases to flow. These men should be selected from the ranks, if possible, and should be men who have developed ability and initiative in their work and they should also have ability to handle the workmen. While a thorough knowledge of how to perform the work is necessary, this is not the first requisite, as ability

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*Abstract of a paper read before a meeting of the Canadian Railway Club, March 8, 1921.

to handle men and personality stand above this qualification. Foremen should be intelligent and fairly well educated in order that they may read the rules, blueprints and instructions and apply them intelligently, and also that they may be eligible for promotion to higher positions as vacancies occur. Wages paid foremen should be sufficiently attractive to create an incentive for the men to fit themselves for such positions.

The successful supervisor, in addition to his knowledge of the work, should show loyalty toward his employer, have the courage to enforce discipline, insist on and obtain a fair day's work from every man in the service, and be absolutely impartial in handling his men in order to obtain and hold their co-operation and respect. He should also have the vision and ability necessary to discover trouble makers and weed them out before the remainder of the organization becomes contaminated. No man should be placed in the position of foreman unless the appointing officer feels that the man selected is capable of developing the necessary initiative and ability to accept any position up to the top of the shop organization, as those men selected for the bottom round of the ladder should be capable of advancing step by step until they reach the top. Most higher supervisory officers have not the time to mingle with the workmen and they must depend on their foremen to provide the little touches of personality and co-operation that are the life of any organization.

Fifth: Another important feature is the personnel of the shops. Wages paid and working conditions should be such that they will attract capable young men to seek employment in railroad shops. Unless this is done, there is a tendency for skilled mechanics to seek more remunerative employment in industrial work. This is particularly true in the large industrial centers. The tendency prior to federal control in some sections of the country, due to shortage of mechanics and inability to induce young men to enter the service, has been to hire foreigners from central and southern Europe, men who have never had any mechanical training, and to try to make mechanics out of them. These men come to us wholly unacquainted with our language, our customs, and our laws, and must be assimilated into our organizations. While at first a rather costly proposition, with proper and tactful handling they usually learn rapidly, and have become the mainstay of some of our car shop organizations. It is important that those charged with the handling of these men, should by careful and tactful treatment instill in them the principle of loyalty to their employers; with proper encouragement and fair dealing on the part of their foreman the majority of these men readily become acquainted with our methods of work. The nationalization of foreigners has become important and it is very generally conceded that they are more easily reached in the shops that in their homes. However, any tendency toward radicalism should be carefully watched and immediate steps taken to circumvent it.

The only commodity a railroad has to sell is transportation. Anything that tends to increase the quantity or speed of transportation is a distinct addition to the wealth and resources of the country. Good, efficient motive power may be essential, but without freight cars the railroads would have little use for locomotives. Estimating that four per cent of all the cars in the country are shopped, every day of unnecessary delay in returning them to service represents a per diem loss to the railroads of approximately $100,000. The importance of providing adequate shop facilities is self-evident.

Suggestion as to Repairs

In the actual work of repairs it is suggested that draft attachments and center construction be sufficiently strengthened so that the shocks incident to modern service will be absorbed and distributed throughout the car, without causing extensive damage to the superstructure. Center and draft sills should have sufficient area and should be protected against buckling by the use of cover plates. A common cause of failure is due to bodies of hopper cars not being securely fastened to center sills. A few rivets are driven in inside hopper sheets to hold the body to the sills, and the heads corrode and wear off, allowing the rivets to pull through the sheets. This results in the whole strain being thrown on the body bolsters, which are usually of a wide single plate type, with the result that they are unable to stand up under the strain. The sills start moving back and forth under the car and it soon gets in such condition that permanent repairs become a rather expensive proposition. Sides and ends of steel equipment should be properly re-enforced to prevent bulging out under load. Drop door equipment should be kept in proper working order to facilitate unloading. Care should be taken in repairing trucks to provide side bearing clearance and to see that brakes and all running gear are kept in good condition.

A well defined program of re-enforcement should be outlined and put into practice on all roads. The cost of such additions and betterments is usually insignificant when the future life and productive service of the car is considered. Money appropriated for such features is a good, sound investment when judiciously used, and should pay large dividends. Many roads make the mistake of repairing their older equipment in kind as they do not have exacting conditions on their lines. Such equipment should either be re-enforced or kept on their own lines and not offered in interchange, where there is a possibility of it getting out into the large industrial centers and in heavy tonnage trains, when it is almost an impossibility to keep it off the repair tracks.

This places an unnecessary burden of expense on both the owner and the handling line. As cars come into the shop for general repairs, a careful inspection should be made, and if the car has not deteriorated to the extent that it is felt advisable to scrap it, it should be repaired in accordance with a well defined re-enforcement program, as outlined. Otherwise, if this is not done, after considerable money has been spent on the car, due to inherent weakness, it will again be back on the shop track.

In conclusion, if the railroads were provided with the facilities and a maintenance program similar to that suggested in the paper was adopted by all roads, and an honest effort was made to maintain the cars in accordance with that program, the steel cars in the country would give the owners a better return for the money invested in the way of better service and in increased life of the cars.

Discussion

There were about 500 in attendance at the meeting; the discussion lasted two hours and had to be cut off because of the lateness of the hour. It was opened by Vice-President Grant Hall of the Canadian Pacific and Vice-President W. D. Robb of the Grand Trunk. A large number of visitors were present from the "States."

In general the discussion indicated that there were few roads owning steel cars which had adequate shops or facilities for taking care of them. The problem has been greatly complicated in the United States by the return of badly deteriorated cars to the home roads at the end of federal control. One road converted an old roundhouse and an old storehouse into steel car repair shops by equipping each of them with facilities and tools costing about $70,000. Five heavy repairs per day are now being turned out of each of these plants.

The metal used in steel cars was seriously criticised because of the rapid rate at which it deteriorates. It was suggested that a better steel be used, similar in composition to the iron used in the Baltimore & Ohio box cars which were built in 1862, the bodies of some of which are still in existence and have not suffered to any extent from rust and corrosion.

Heavier motive power and careless switching of cars has been responsible in part at least for the failure of some of the earlier designs of steel freight cars.

What is needed more than anything else is a systematic program for making heavy repairs to freight cars so that a certain percentage of the equipment will be given such repairs each year—this percentage to be based upon the number of years which a car can safely run between heavy repairs. Locomotives are shopped on a mileage basis. Why not establish a reasonable and scientific basis upon which to shop freight cars and then see that it is lived up to? This will keep the equipment in prime condition and at a minimum of expense after the program has been well established. It will be necessary to speed it up for some time, however, in order to catch up with the deferred maintenance.

Draft Gear Tests of the Railroad Administration

Results from Gears After Three Years' Service; Destructive Tests and Rivet Shearing Tests

The results of the tests with friction surfaces coated with foreign matter indicate that while new gears in laboratory tests may show acceptable capacities, depreciation may occur in service, not only from eventual wear, but from an immediate coating of the friction surfaces.

It has not been possible to investigate this as thoroughly as desired, but some little work of this character has been done in conjunction with the engineer of tests of the Norfolk & Western Railway. Experiments were made upon five different types of gears which had been in service for approximately three years each on N. & W. 100-ton coal cars. The gears were carefully removed from the cars so as not to disturb the deposit and glazing on the friction surfaces and were put in tight, individual boxes and carried immediately to the drop test machine.

The actual fall required to close the gears in their service condition was determined in as few blows as possible, after which a building up or restoration test was made by giving the gear additional blows until no further increase in capacity could be obtained. No attempt was made to clean the surfaces of these gears prior to the building up tests, as the test was intended to develop what recovery might be effected by simply working the gear. The gears were all in good condition as to wear, and would in every instance have been so declared upon surface inspection. The results of these tests are shown in Table IV.

Table IV—Drop Tests of Friction Gears Which Were Taken Out of Service, Norfolk & Western Railway

		Average results—9,000 lb. drop			
Make and type of gear 1	Number of gears tested 2	Drop test value of new gear total fall, in. 3	Total fall required to close gears when first removed, in. 4	Gear restored to—total fall, in 5	Number of blows necessary for restoration 6
Miner, A-18-A	10	19.9	16.4	17.5	18
Miner, A-59	2	27.0	18.0	20.5	32
Sessions, K	2	19.3	8.6	9.0	14
Sessions, Jumbo	2	28.1	15.0	16.5	21
National, H-1	10	31.2	19.4	26.9	32

In explanation, the Miner A-18-A gear is the same as the Miner A-18-S of the U.S.R.A. tests, except that the A-18-A has 3 in. travel and the A-18-S has 2½ in. travel. The Miner A-59 gear is an especially long gear, not usable in the standard pocket and hence not included in the U.S.R.A. tests. The Sessions K, the Sessions Jumbo, and the National H-1 are identical with the same types of draft gear in the U.S.R.A. tests.

Column 3 gives for ready reference the total average drop test value of the several types, when new and in good condition, as found in the U.S.R.A. tests. The Miner A-18-A is taken the same as the A-18-S. For the Miner A-59 a value is taken from previous tests of these gears.

Column 4 gives the average total fall, including the travel, required to just close the gears when first tested after removal from service. These figures therefore represent the value of the gear as in actual service, after a period of three years' use, as heretofore explained.

In this test the Sessions gears, which have the friction elements of unhardened cast iron working against unhardened forged steel, showed the greatest percentage of depreciation and the least restoration. The National gear, which has hardened steel friction elements working together, showed the next greatest percentage of depreciation and the greatest restoration. The Miner gears, which have hardened steel friction shoes working against a malleable iron barrel, showed the least percentage of depreciation and necessarily the least percentage of restoration. It does not thus appear that the character, and particularly the hardness of the friction surfaces, influenced this depreciation. On the other hand, the Miner gears were under a heavy initial compression in the cars and the Sessions and National were under practically none.

It is therefore probable that the tightness of the friction parts may have prevented the entry of the foreign material in the case of the Miner gears. In the case of these N. & W. gears, the friction shoes in the Miner gears were in every instance tight with the gears in position in the cars, while the friction members were loose in every one of the Sessions and National gears. As no measurable wear had occurred in the National gears the manufacturers offer in explanation of this loose condition of the friction members that an inferior lot of springs had been used, with consequent set and loosening of the friction parts in the car. In the case of the Sessions gears the designs provide for loose friction blocks in the car. Further investigation along the lines of gear depreciation, due to foreign material on the friction surfaces in service, should be made.

Destructive Tests

Immediately after the tests with coated friction surfaces, the same gears, one of each of the types included in the program, were tested to at least partial destruction under the 9,000 lb. drop, the gears being supported on a solid anvil. In each instance successive blows were given from heights beginning at 1 in. free fall of the weight and increasing by 1 in. increments, a record being made of the point at which each gear went solid and of the point at which destruction began, as evidenced by scaling, fracture, bending or shortening of some part of the gear. These tests are of the kind best suited to show the ability of a gear to receive over-solid blows and are designed to penalize weakness instead of putting a premium upon it, as set forth in a preceding chapter of this report. It will be noticed that some of the gears begin to show evidence of distress at a fall of just a few inches above the solid point.

Summary of Destructive Tests

The table No. V has been prepared to show the results of these tests and to grade the gears as to destructive value. It is quite possible that a repetition of lighter blows would in each instance have produced failure, but it is believed that no great error is made by this comparative grading.

Column 3 gives the total fall required to close the gears during this particular test. In some instances this varies slightly from the figure obtained in the original drop tests, due usually to the fact that some of the gears could not be fully restored in the immediately preceding tests with coated friction surfaces.

Table V—Performance of Gears in Destructive Tests

		9,000 lb. weight				
Make and Type of Gear 1	Test Gear No. 2	Total fall required to close gear in this test 3	Additional fall beyond closing point required to start failure 4	Development of failure 5	Average total fall 9,000 lb. weight required to close one commercial gear of this type Inches 6	Destructive value assigned to this type of gear. Inches fall 7
Westinghouse D-3	1	18.5	4	Rapid	19.8	23.8
Westinghouse NA-1	6	27.0	4	Rapid	26.0	30.0
Sessions K	10	15.2	2	Rapid	18.8	19.8
Sessions Jumbo	13	24.1	4	Slow	28.1	32.1
Cardwell G-25-A	16	20.8	2	Rapid	18.9	20.9
Cardwell G-18-A	19	20.3	3	Rapid	19.6	22.6
Miner A-18-S	22	16.5	7	Medium	19.9	26.9
Miner A-2-S	25	12.5	7	Medium	13.2	20.2
National H-1	28	33.5	17	Slow	31.2	48.2
National M-1	31	19.5	10	Slow	19.2	29.2
National M-4	34	19.5	6	Slow	21.5	27.5
Murray H-25	37	17.7	5	Medium	17.0	22.0
Gould 175	40	17.4	4	Medium	18.1	22.1
Bradford K	45	11.5	1	Rapid	10.8	11.8
Waugh Plate	48	12.2	2	Slow	13.9	15.9
Christy	51	14.3	8	Slow	19.6	27.6
Harvey 2-8 in. by 8 in. springs	54	7.9	5	Melium	9.5	14.5
Coil springs 2-8 in. by 8 in. Class G	57	5.8	2	Rapid	5.8	7.8

Column 4 gives the additional height from which the 9,000 lb. weight was dropped, reaching this by increments of 1 in. from the solid point, before visible distress of the gears began.

Column 5 has been inserted to denote whether the failure from this point on developed slowly or rapidly, under constantly increasing falls.

Column 6 gives for reference the figure accepted as the average total fall required to close a new commercial gear of this type, when in good condition, this column being the same as Column 10, Fig. 16.

Column 7 gives the comparative destructive values assigned the several types. This figure is obtained by adding to the average drop test value of the type of gear as given in Column 6, the over-solid values in Column 4. Thus in the case of the Westinghouse D-3, gear No. 1 of this type was subjected to this test. During the test gear No. 1 went solid at a total fall of 18½ in. and at a total fall of 22½ in., or 4 in. above the solid point, the barrel started to fail. Accordingly the destructive value of this gear has been set by adding 4 in. to the average total fall figure 19.8 in., giving a destructive value of 23.8 in. The same practice has been followed for all gears.

Rivet Shearing Tests

The draft gears for the U.S.R.A. cars were purchased on the requirement that they be of "150,000 lb. capacity" and the Mechanical Committee later defined a 150,000 lb. capacity draft gear in the following words:

"A 150,000 lb. draft gear should be defined as one that will sustain a drop of 16 in. (including travel of gear) of a 9,000 lb. weight, without shearing the rivets of one or both lugs, which are to be secured to suitable supporting members by nine ½ in. rivets of .15 carbon or under, driven in 9/16 in. holes."

A representative number of gears of each type used on U.S.R.A. cars were selected at random and subjected to the above test. The average of the results for each type was used to determine whether or not that type of gear met the terms of the specifications. In these tests the gears were supported upon a solid anvil and the weight was dropped from successive heights, increasing by 1 in. increments until the rivets sheared.

In testing the Sessions K gears, the highest capacity gears sheared the rivets at a lower drop than the lower capacity gears. In five instances the rivets sheared before the solid point of the gear was reached. In three instances the rivets sheared at the point of gear closure; and in but two instances did it require a blow from above the solid point to shear the rivets. In three instances the rivets were sheared at a point below the specification requirement when the successive blows by 1 in. increments were given the rivets. In each of the cases, however, when the gear was again set up and a single blow given from a height sufficient to produce a total fall of 16 in. the rivets did not shear. Thus, one of these gears, when given blows increasing by 1 in. increments, sheared the rivets at a total fall of 11 in., and when it was immediately thereafter given a single blow from a total fall of 16 in. the rivets were not sheared. The rivets in this re-test sheared at the next blow, or at a total fall of 17.2 in.

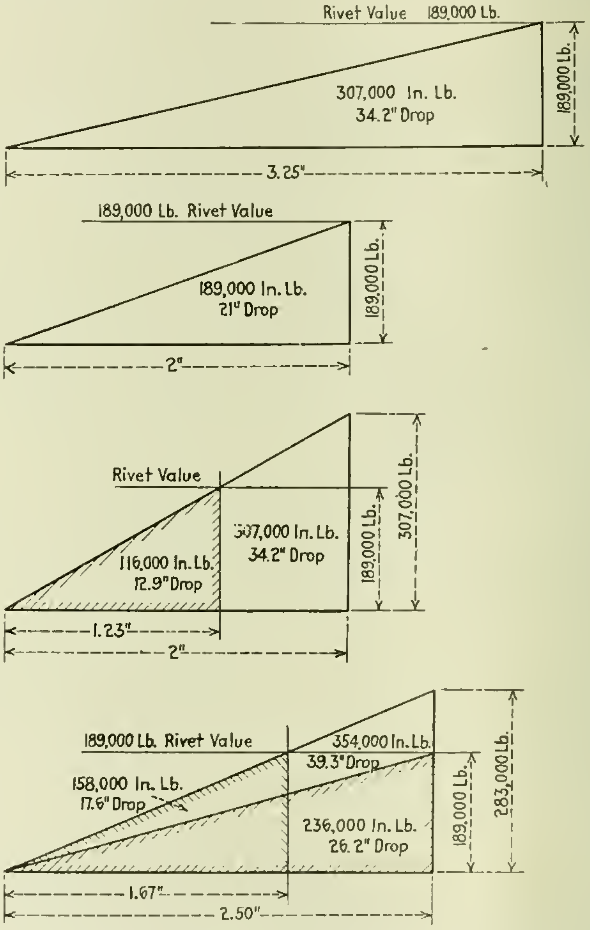


Fig. 3—Diagrams of Rivet Shearing Action of Draft Gears

For the Sessions gears it required on the average 2.7 in. less fall to shear the rivets than to close the gears. In the

Westinghouse D-3 gears the rivets usually sheared 1 in. above the solid point, although in a few instances it required an over-solid blow of 2 in. to produce shear. In the Cardwell G-25-A gears it required on the average an over-solid blow of 3.2 in. to shear the rivets. In one instance a 4 in. over-solid blow was necessary. In the Murray H-25 gears it required an average over-solid blow of 2.4 in. to shear the rivets.

Considering the Westinghouse, Cardwell and Murray gears, it will be noted that the number of over-solid blows required to shear the rivets is in inverse relation to the over-solid sturdiness or destructive value of the gears as given in Table V. The short travel of the Sessions K gear necessitates a higher ultimate resistance, so that the elastic limit of the ½ in. rivets is passed before the gear goes solid. In considering this test it should be remembered that the eighteen ½ in. rivets (9/16 in. when driven) have a shearing area of 4.47 sq. in., giving an ultimate shearing value of approximately 189,000 lb., with an elastic limit in shear of approximately 135,000 lb. In practice the rear draft lugs each have twelve ⅞ in. rivets in 15/16 in. diameter holes, or a shearing area of 16.57 sq. in., with an ultimate shearing value of 700,000 lb., or an elastic shearing limit of 500,000 lb.

Table VI has been prepared to show the results of these ½ in. rivet shearing tests made for the acceptance of gears for U.S.R.A. cars.

TABLE VI—RESULTS OF ½-IN. RIVET SHEARING TESTS. DRAFT GEARS FOR U. S. R. A. CARS 9,000-LB. DROP

9,000-*Lb. Drop*

Make and type of gear	Number of gears tested	Total fall to close gear, inches			Total fall to shear rivets, inches		
		Maximum	Minimum	Average	Maximum	Minimum	Average
1	2	3	4	5	6	7	8
Westinghouse D-3..	18	21.6	18.6	19.9	22.6	19.6	21.0
Sessions K	10	23.1	18.1	20.5	22.1	11.0	17.8
Cardwell G-25-A....	5	17.6	15.6	16.6	20.6	19.5	19.8
Murray H-25.......	7	17.8	16.8	17.6	20.8	17.8	20.0

In order to show for comparison how all of the gears perform in this test, and in order to study the specifications in the light of a full knowledge of each particular gear, one of each type of gear in the tests was subjected to the ½ in. rivet shearing test. This was done after the car-impact tests and was the final test given the gears.

The results are given in Table VII, the several columns of which are described as follows:

TABLE VII—PERFORMANCE OF GEARS IN ½-IN. RIVET SHEARING TESTS

Type and make of gear	Test gear number	Total fall required to close this gear solid anvil, Inches	Free fall required to shear rivets, Inches	Travel of gear when rivets sheared, Inches	Total fall required to shear rivets, Inches	One or both lugs sheared
1	2	3	4	5	6	7
Westinghouse D-3....................	2	19.50	17	2.47	19.5	one
Westinghouse NA-1...................	7	26.00	21	2.66	23.7	both
Sessions K..........................	11	20.06	11	1.45	12.5	one
Sessions Jumbo......................	14	27.06	14	2.10	16.1	both
Cardwell G-25-A.....................	17	20.75	20	2.75	22.8	one
Cardwell G-18-A.....................	20	18.29	18	3.29	21.3	one
Miner A-18-S........................	23	19.52	17	2.47	19.5	one
Miner A-2-S.........................	26	13.53	11	2.53	13.5	one
National H-1........................	29	32.50	9	1.00	10.0	one
National M-1........................	32	18.53	17	2.53	19.5	one
National M-4........................	35	23.46	17	2.30	19.3	both
Murray H-25.........................	38	16.47	16	2.47	18.5	both
Gould 175...........................	41	17.44	16	2.44	18.4	both
Bradford K..........................	46	8.44	8	2.44	10.4	one
Waugh Plate.........................	49	13.25	11	2.25	13.3	one
Christy	52	18.21	12	1.95	14.0	one
Harvey 2-8 in. by 8 in. springs....	55	10.76	8	1.76	9.8	one
Coil springs 2-8 in. by 8 in., Class G.	58	5.70	7	1.70	8.7	one
Solid steel block...................	..	...	4	...	4.0	....

Column 3 gives the original total fall required to close each gear. During this test care was taken to see that all gears were up to this original capacity.

Column 4 gives the free fall required to shear the rivets of one or both lugs. This height of fall was reached through successive blows increasing by 1 in. increments.

Column 5 gives the actual amount of gear closure obtained in this test with the free fall of Column 4.

Column 6 gives the total fall required to shear the rivets, this being the sum of the quantities in Columns 4 and 5.

Column 7 denotes whether one or both lugs sheared, this, however, being of secondary interest.

In each of these tests the rivet samples were analyzed and the carbon content in no instance exceeded .15, the usual average ranging from .09 to .12.

Some of these results will, at first thought, appear inconsistent, but a more careful study will show that the results in general are approximately what should be expected when gears of different travels and capacities are tested upon undersized rivets. Thus the gears generally may be divided into two classes: those closing at four miles per hour or more in the car-impact tests and those closing at less than four miles per hour. Seven types as follows fall in the higher class:

National H-1.
National M-1.
National M-4.
Miner A-18-S.
Westinghouse NA-1.
Sessions Jumbo.
Sessions K.

It will be noted that in no case did a gear of this class require an over-solid blow to shear the ½ in. rivets. In six cases the rivets sheared before the gears went solid and in the remaining case the rivets sheared at the solid point. Furthermore, as might be expected, the gears of short travel usually sheared the rivets earlier than those of equal capacities and longer travel.

A more clear understanding of this action will be had from the diagrams of Fig. 3. At the top of this figure is shown a straight line diagram of a gear of 34.2 in. drop capacity and of 3¼ in. travel. The ultimate resistance of this gear is 189,000 lb. and the eighteen ½ in. rivets should shear at the same value, or just when the gear goes solid. Next there is shown a diagram of a 2 in. travel gear of the same ultimate resistance, 189,000 lb., and with this gear also the rivets should just shear at the solid point, but which in this case would be at 21 in. drop instead of 34.2 in. Next is shown the diagram of a gear of 2 in. travel but of the same capacity (34.2 in. drop) as the 3¼ in. travel gear at the top of the figure. The ultimate resistance of the gear would in this case be 307,000 lb. and the rivets, which have the value of 189,000 lb., should shear at 1.23 in. gear travel or at a drop of but 12.9 in. This gear, therefore, which is of the identical capacity as the 3¼ in. travel gear, will shear the rivets at 12.9 in. drop, whereas the 3¼ in. travel gear will require 34.2 in. drop. This increase in drop is due solely to the increased travel of the gear with consequent decrease in ultimate resistance. At the bottom of Fig. 41 are shown superimposed diagrams of two gears, each of 2½ in. travel, but the one of 26.2 in. drop capacity and the other 39.3 in. drop capacity, or just 50 per cent increase. In the case of the lighter capacity gear the rivets do not shear until the gear goes solid or at 26.2 in. fall. In the case of the larger capacity gear the rivets would shear at 17.6 in. drop. Here is shown how by simply increasing the capacity of the gear 50 per cent the ½ in. rivets are caused to shear 13.1 in. lower than with the lighter capacity gear. These conditions are for straight line gears and for shearing the rivets at a single blow. When a succession of blows is given from varying heights the difference becomes even more marked, as a heavier capacity gear begins to punish and permanently deform the light rivets early in the test.

The above principles are reflected in the test results. Thus the Sessions K gear and the Cardwell G-25-A were of practically equal drop test capacity but different travels, namely, 2 1/16 in. and 2¾ in. respectively. The Sessions K gear (2 1/16 in. travel) sheared the rivets at 12.5 in., while the Cardwell (2¾ in. travel) sheared them at 22.8 in. Again, the National H-1 gear sheared the rivets at 10 in. fall, while the National M-1 gear sheared them at 19.5 in. fall. Here the travels of the gears are the same, but one gear had a drop test capacity of 32.5 in., while the other had 18.5 in.

An effort was also made to test all the gears on full-sized rivets, a total of twenty-four ⅞ in. rivets (16.57 sq. in.) being used for the two lugs. The three gears tested in this way failed which showed the futility of attempting to use this method of testing. From this experience and from careful study, it is believed the present ½ in. rivet shearing test is not a fair method of grading gears. Car sills are designed for a load of 500,000 lb. and it therefore should not be expected to hold the draft gear to the limits required by this light test. It is believed possible, however, to develop a rivet shear test to grade gears of all capacities, and investigations have been outlined to develop a test of this character. In this work the following points will be established or disproved:

1. That rivet shearing tests should be designed to show smoothness of action and the ultimate dynamic resistance.
2. That such tests should not be carried beyond the solid point of the gear, because of the fact that all gears are not of equal rigidity when solid.
3. That the rivets should be of such area that a single blow may be given from a stated height, within the capacity of the gear, and the rivets not be sheared.
4. That the rivets should shear at a blow from not more than a stated height above the solid point; this in order to penalize over-solid weakness of construction.
5. That the tup should not be dropped through successive heights increasing by 1 in. increments because of passing the elastic shearing limit of the rivets before the gear is solid, but that the gear should be set up on lugs or the equivalent and a single blow given from a specified height for that particular gear and the rivets not be sheared. Using a new set of lugs, another single blow should be given from a second specified height at which the rivets should shear.
6. That the number of rivets used and the heights of drop should not be the same for all gears but should be set for each type in accordance with its capacity and travel.
7. That the rivet area and height of fall should be determined by the drop test capacity and travel of the gear.
8. That the test rivets should be of high carbon steel or other material having a high elastic shearing limit; this in order to avoid the uncertainty of the exact shearing point.
9. That when all gears are constructed of equal travel the question of rivet shearing tests will be greatly simplified.

Car Inspectors Propose Change in Interchange Rules

Suggestions Largely Intended to Remove Conflicts and to Effect Uniformity of Application

In the April issue of the *Railway Mechanical Engineer*, page 233, appeared the first installment of the transcript of the proceedings of an open meeting of the executive committee of the Chief Interchange Car Inspectors' and Car Foremen's Association of America, held at the Hotel Sherman, Chicago, on March 3 and 4, 1921, for the purpose of recommending changes in the Rules of Interchange. The following is a continuation of the discussion which took place at that meeting.

At the opening of the session on March 4, attention was called to the fact that Henry Boutet, one of the founders of the Association and chief interchange inspector at Cincinnati, Ohio, was unable to be present on account of serious illness, and the secretary was instructed to express to him in suitable manner the sympathy of the members present.

Proposed Change in Rule 4

M. E. Fitzgerald: I move the following change in Rule 4:

> Eliminate from the fourth paragraph of Rule 4, the words "with the exception of the cases provided for in Rules 56, 57 and 70."

Rule 56 pertains to cars intended to be equipped with metal brake beams and so stenciled if found with wooden brake beams. Rule 57 has to do with cars not equipped with A. R. A. standard 1⅜" air brake hose, and Rule 70 deals with steel wheels. . It is absurd to permit the owners of equipment to hold you responsible for wrong repairs to steel wheels, when they will not give owners who have cars equipped with more expensive devices similar protection. The case of the brake beams is fully taken care of and if an intermediate line repairs a car with wooden brake beams under it, they may bill the owner. If the car is stenciled the owner must use his repair cards as joint evidence. In the case of the wheels we have a recent arbitration decision. This is a defect that cannot be detected at night and the handling line, that did not make the repairs, is heavily penalized when it should not be.

Chairman Gainey: I do not agree that those defects cannot be detected at night. If a man cannot detect a cast iron wheel from a steel wheel, we might as well quit inspecting at night.

M. E. Fitzgerald: Cast steel wheels are overlooked because the stenciling is bad. In many cases owners are putting them in and permitting the cars to run and the handling lines are being heavily penalized. You have a car equipped with steel sills and you pull them out and put in wooden timbers. The only redress the owner has is joint evidence. There is as much money involved as in steel wheels; why shouldn't the man with the steel wheels do the same thing?

The motion was seconded and carried.

Mr. Pellien's motion was carried.

Change in Preface

F. H. Hanson: I would like to make recommendations for a change in preface of these rules. The first paragraph reads as follows:

> These rules make car owners responsible for, and therefore chargeable with, repairs to their cars, *except as otherwise provided.*

I move that the words "except as otherwise provided" be stricken from the rules for the reason that they are nothing but a loophole giving various roads a chance to deviate from the M. C. B. rules. If we are going to have rules, let us make them so they can be lived up to in one part of the country as well as in another part of the country. Recently we had an agreement under consideration and when I took it up with the other party as to why they wanted certain paragraphs in the agreement, when I thought all that was necessary was to say that the interchange would be handled in accordance with interchange rules, they called attention to the preface saying "except as otherwise provided" and said that they expected to take advantage of those words.

The motion was seconded.

F. W. Trapnell. "Except as otherwise provided" refers to Rules 32, 48 and 49.

C. M. Hitch: How can any interchange association or any other body make a local agreement?

F. W. Trapnell: I do not know of any local agreements running in the country today with any interchange associations except as to costs. There is a provision in the transfer rule whereby the A. R. A. says "unless otherwise provided." That is merely a matter of otherwise providing for the collecting of the cost of the transfer.

C. J. Wymer: Automatically this abrogates all of the penalty rules. I do not like to be quite so radical.

A. Herbster: Could that not be taken care of by making it read "Except as otherwise provided in these rules"?

F. H. Hanson: I did not mean to take out the responsibility contained in Rule 32. I would like to see the rules so worded as to still keep in effect Rule 32 as far as wrecks, derailments, etc., are concerned, without allowing any road to draw up any agreement that will conflict with the A. R. A. Rules.

The motion was lost.

Rule 9

M. E. Fitzgerald: I move that a reference be put in Rule 9, page 28, that repairing lines must state the type of triple valve when stenciled on the car, or not stenciled.

The motion was seconded and carried.

Rule 14

F. W. Trapnell: Under Rule 14, second paragraph, it says:

> Facing the B end of car, in their order on the right side of car, wheels, journal boxes and contained parts shall be known as R1, R2, R3 and R4, and similarly those on the left side of car shall be known as L1. L2, L3 and L4.

I move that the side of a car be from corner post to corner post on the right side, and from corner post to corner post on the left side in accordance with this rule.

The motion was seconded and carried.

Rule 17

F. H. Hanson: Referring to paragraph I, second paragraph, Rule 17, which reads:

> Cotter keys are not to be applied to knuckle pins of couplers on cars other than hopper and fixed-end gondolas.

I move that it be changed to read:

> Cotter keys to be applied to knuckle pins of couplers on all open top equipment except flat cars.

Practically all open top equipment is used in dumping machines.

The motion was seconded and carried.

M. E. Fitzgerald (C. & E. I.): I do not recall having heard any discussion on Rule 3. There is confliction between Rule 2 and Rule 3. For instance, Rule 3 says that cars will not be accepted in interchange unless equipped with all metal brake beams. What should you do with the car under load? Rule 2 says loaded cars must be accepted, and it specifies certain exceptions, which are not those in Rule 3. I move that it is the opinion of this Association that the reference in Rule 3 covers loaded or empty cars.

Secretary Elliott: What paragraph?

M. E. Fitzgerald: All of them. I merely called your attention to one. If the car is offered to you loaded and you accept it and run it and again load it, you never get to the point where the correction called for in Rule 3 is made. You should make the delivering line apply the metal brake beams before they offer the car, either loaded or empty. The rule merely says "Car."

The motion was seconded.

J. J. O'Brien: Do I understand Mr. Fitzgerald's motion to mean that he desires to stop the movement of traffic on loaded equipment simply because the car has wooden brake beams? I do not think we want to go on record as interfering with the loaded equipment. Rule 2 specifically states that loaded cars shall not be rejected. On empty cars it is different.

M. E. Fitzgerald: Rule 2 says that loaded cars must be accepted with certain exceptions. Rule 3 states plainly that cars will not be accepted in interchange unless equipped with all-metal brake beams, and several other items. What is the inspector going to do? I want the rule written so he is clear on it. The items I refer to are minor repairs,—brake beams and hooks on refrigerator cars to hold the doors open,—and when that rule was made it was the intention to enforce the application of those standards. If you permit the car to move and I accept it under load and run it with the wooden brake beams, I unload it, load it again and permit it to run with those brake beams and the other fellow has to take it. You will eliminate the necessity for the rule if you enforce it as the Association intended. Tie the car up and make the road with the car in its possession apply those standard features; that was the object of the rule.

C. J. Wymer (C. & E. I.): If this is intended to apply to empty or loaded cars, it ought to say so; it is in contradiction to Rule 2. If it only applies to empty cars, it should say so and remove that conflict.

The motion was carried.

F. H. Hanson (N. Y. C.): Rule 18, page 37, reads:

> When A. R. A. couplers of another make are applied to a car, the uncoupling arrangement shall be made operative at the expense of the company making the repairs.

I move that the following be added to that paragraph:

> except when applying Type D couplers in place of old style couplers.

In that event the expense for applying the uncoupling attachments should be borne by the car owner.

The motion was seconded and carried.

Mr. Jameson (Southern): The second paragraph of Rule 22 reads in part:

> Longitudinal sills (intermediate or side sills) may be spliced at both ends, on either side of body bolster.

A strict interpretation means that you cannot splice center sills except at one end of the car. Should it not read:

> Longitudinal sills may be spliced at both ends.

C. J. Wymer: The rule says "Longitudinal sills (intermediate or side sills)". That tells you what is meant by longitudinal sills. It confines the rule to intermediate and side sills, otherwise there would be no need for the parenthesis.

P. M. Kilroy (St. Louis-South Western): It seems to me that is put in to meet the point raised. It is enclosed in parenthesis to make it clear that you can do exactly what he says you cannot do.

M. E. Fitzgerald: As I read that rule, if you want to find out about splicing sills on either end you would read, "Longitudinal sills may be spliced at both ends," then, "intermediate or side sills on either side of the body bolster." Then find out what you can do with the center sills. The intermediate and side sills may be spliced on either side. The rule is clear and you can splice all longitudinal sills on both ends.

Mr. Jameson: I agree that is what the rule meant to convey, but it does not so state.

A. Herbster (N. Y. C.): Shouldn't the correction be in the second paragraph on page 40, which deals with the splicing of center sills?

Mr. Jameson: I move that we amend this by making it read:

> Longitudinal sills may be spliced at both ends. Intermediate or side sills on either side of body bolster.

The motion was seconded and carried.

C. M. Hitch (B. & O.): Referring to Rule 23. I understand there was quite a discussion not long since by a body of car men as to what portion of a cast steel truck side comprised what is termed the "tension member." I would like to ask the views of this body on that question.

W. K. Gonnerman (B. & O.): I have always considered the lower part the tension member and the upper part the compression member.

H. W. L. Porth (Swift & Co.): From an engineering viewpoint there are only two pieces of truck side frame that are tension members and those are the columns. The forces that take place in the so-called bottom cord are alternating; they may be either compression or tension. That has been demonstrated in tests at Purdue University and also in tests made at the University of Illinois.

P. M. Kilroy: It is true that from an engineering standpoint the columns are the true tension members, but there is also considerable tension between the oil box and the column in the bottom member, it may be alternating just as Mr. Porth says—but I think it would be perfectly clear to say that the top member was in compression and the bottom one in tension.

M. E. Fitzgerald: If that is a fact, the prints submitted by the A. R. A. are improperly marked.

H. W. L. Porth: That is the exact reason why the Committee on Welding marked the prints as they did,—from the tests that have been made at Purdue and Illinois. They found that these alternating stresses are in the members of the so-called bottom chord between oil boxes.

C. M. Hitch: That answers my question in a way, but I believe the bottom member of the cast steel truck side is termed the "tension member" and I believe that was the portion of the truck side it was intended should not be welded, for the reason that most of the trouble is in this member. I consider it a dangerous practice to attempt to weld it.

Inasmuch as it has been discussed by other bodies as well as here today, I move that this body ask the Arbitration Committee for an interpretation as to what portion of the cast steel truck side frame constitutes the tension member and what constitutes the compression member. *The motion was seconded.*

E. H. Mattingley (B. & O., C. T.): I would like to request Mr. Hitch to include in his motion that a foot-note be added stating that this refers to bottom members only. I do not believe, gentlemen, that there are any car men handling the repairing of cars today who do not consider the bottom member of the truck side frame as the tension member. You may talk about your engineering features, etc., but it practically replaces with a later modern device the arch bar, as the gentleman illustrated. The Arbitration Committee and the Welding Committee had in mind, as I understand it, that the bottom member of the side truck frame should not be welded.

Mr. Mattingley's suggestion was included in the motion.

M. E. Fitzgerald: If this goes into effect, hundreds of cars already welded will be refused in interchange as not complying with the rules. Some exceptions will have to be made as to dates of welding, excepting those previously welded on authority of the Association's prints.

C. M. Hitch: If this is submitted to the Arbitration Committee it will go to the proper place to be determined. It should be determined because car men are in doubt as to its meaning throughout the country.

The motion was carried.

Mr. Pellien (Ass't. C. I. I., Buffalo, N. Y.): Under Rule 32 I would like to insert a new paragraph. Call it paragraph (0):

Damage to any car if caused by clam shell or bucket in loading or unloading.

Many cars are being damaged in this manner at industrial plants, which damage cannot be termed other than unfair handling and is not protected by the present rules. We are having a number of those cases in the Buffalo district and we feel that Rule 32 is not explicit enough to place the responsibility with the delivering line.

I move that this change be recommended.

The motion was seconded and carried.

M. W. Halbert (Chief Inspector, St. Louis, Mo.): I move that the first paragraph of Rule 32 be changed to read as follows:

Dome covers, safety valves or outlet caps missing from tank cars.

It is felt that the importance of the outlet cap should be so generally recognized that the attention given it would make it next to impossible for it to be lost under fair usage.

The motion was seconded.

F. W. Trapnell (Kansas City, Mo.) Suppose this tank is shifted and the outlet boot is broken off and missing, we would have to card the cap but would have no place to put it on because the owner would be responsible for the outlet boot.

M. W. Halbert: That is only a technical point; we all know there are a great many of these outlet caps left dangling to the chain. They are not put in the proper place and they become lost.

Secretary Elliott: The case Mr. Trapnell mentioned is exceptional. From the experience we have had with tank cars, I think when the outlet cap is gone it is through carelessness, not through maintenance. They are so important that they should be maintained. That note will be a reminder to the car inspectors to particularly notice those things.

F. W. Trapnell: At large interchange points we find it to be a fact that with that outlet cap on, they fail to close their outlet valve. The minute the least thing goes wrong you have lost your tank of oil. The car goes to the man at the refinery or to the owner of the tank. He unloads it, leaves his outlet cap down, and if it hangs low enough to strike the rails, it is lost when the switching crew comes in to switch that car out, perhaps on the right of way of the refinery that owns the tank. Then the car is handled maybe fifty or sixty miles and delivered to somebody else. You want to penalize the railroads for the owner's carelessness. The roads do not have inspectors at all of those points by any means. I do not believe that they should be made the delivering line's responsibility.

Mr. Koeneke (Indiahoma Refining Company): It is absolutely obligatory to load the car with the cap off. The valve must be tight or the car cannot be loaded. Furthermore, if a car is shipped to an industry on a railroad and a cap is left off after unloading, it is the railroad inspector's duty to see that the cap is applied. It is against the regulations of the Bureau of Explosives to leave the cap off.

F. W. Trapnell: I was chairman of a committee that visited about seven refineries in our territory with a delegation of foremen appointed by the Superintendent's Association and no one knew of our mission. In one case we asked a foreman to take off several caps. Two of them were leaking a stream bigger than your two fingers. Those caps were never off when he started to load.

A. S. Sternberg (Belt Ry. of Chicago): We have had two cases lately with ice frozen in above the caps. When the cars were loaded the valve was screwed down and they thought it was closed because it was solid against this chunk of ice. It was one-fourth open. That indicates that the cap was not taken off. The thawing out or something else broke the cap and we lost the entire tank of oil.

M. E. Fitzgerald: This argument is to the effect that the caps are on the cars. Mr. Halbert merely wants to penalize you when they are not on the cars.

The motion was lost.

Mr. Owen (Peoria, Ill.): On Rule 32, paragraph (N), I move that failure to close hopper doors or drop bottom doors on coal cars be made the delivering line's responsibility and cardable in interchange. This is to insure that the doors are properly closed so the cars are suitable for loading. Many doors are coming down after they have been partly put up and the change in the rule is for the safety of the train men in handling.

The motion was seconded and on vote was lost.

Chairman Gainey: Referring to the part of Rule 32 that reads:

Damage to any car (including cars on ferries or floats) if caused by:
(a) Derailment.
(b) Cornering.
(c) Sideswiping.

If you are shoving a cut of cars down through the yard and a flat car breaks in two, the trucks run together and probably one or two pairs of the wheels go off the track. It is argued that was not caused by a derailment, that it was caused by the car breaking in two. I think that part of your rule ought to be changed and made more clear.

M. E. Fitzgerald: Isn't it a fact that we have interpretations to the effect that you may break a car in two? If you break it or the air hose bursts and the wheels do not leave the rails, such a condition would be owner's responsibility. If the car left the rails, even though you could prove that it was due to the air hose bursting, it would be a delivering line's responsibility because the car was derailed.

Chairman Gainey: Your rule says, "If caused by," and the cause was not the derailment of the car. It broke in two before it was derailed and the car breaking in two—which is owner's responsibility in fair usage—caused it to be derailed.

F. W. Trapnell: The Arbitration Committee gave us a ruling on that. There was a car up in the Cascade Mountains on the Great Northern. It was broken in two, fell off to one side and pulled the truck off with it. They ruled that the car was derailed and that it was the delivering line's responsibility.

C. M. Hitch: This is not the same case. The car was derailed and rolled off down the bank. Chairman Gainey refers to a car that remains above the rails on the trucks with some of the wheels on the ties. In some cases they claim that is the handling line's responsibility and in other cases they say it is the owner's responsibility. Let us have an interpretation.

Chairman Gainey: I think that the Arbitration Committee's ruling is right, but the rule should be worded differently. Why not change it to read:

Damage to any car (including cars on ferries or floats) if:
(a) Derailed.
(b) Cornered.
(c) Sideswiped.

A motion to recommend this change was made and seconded.

Mr. Owen: If you have a collision or impact that would cause damage to that car sufficiently to cause it to leave the rails, paragraph (D) would cover that, would it not? I understand that the transportation department considers approximately six miles an hour as a speed of safety in switching. If they are going twenty-five miles an hour, it seems to me it is unfair usage and rough handling. If there is an impact or collision sufficient to damage the equipment and knock it off the track, it would be a handling line's responsibility.

Chairman Gainey: That is not the point I am trying to get at. If I am shoving a cut of cars, ordinarily switching, and that cut of cars breaks in two and two trucks run together and the body fell over, it would be an owner's defect unless one pair of wheels dropped from the rail; then it is a handling line's defect, regardless of how it happened. That is why I say the wording is not right.

M. E. Fitzgerald: The motion will cover that particular case, but you have eliminated all of the other provisions of the rule. You have not followed it up with a provision covering the other paragraphs of Rule 32. The rule would then read that you are only responsible to the owner for a car derailed, cornered or sideswiped, not responsible for material stolen, etc., as incorporated in the rule.

F. C. Schultz (Chief Interchange Inspector, Chicago): I think this whole rule is wrong. The old system of combination is properly regulated. What is the difference whether one wheel or both got off?

M. E. Fitzgerald: I quite agree with Mr. Schultz that the rule is all wrong. We were arguing on a certain motion, however, and I think, taken in connection with Rule 43, you practically have the combination. There is no provision in Rule 32 protecting the owner or connecting line receiving a car so damaged, the car coming under Rule 43. I think this should be referred to a committee and settled here.

F. W. Trapnell: That is the way to handle it,—put in the combination.

Chairman Gainey: We can pass this over until tomorrow.

The motion was withdrawn.

M. E. Fitzgerald: Paragraph (E) reads:

Handling of cars with broken or missing couplers or couplers out of place.

Follow that by saying:

Except in cases provided for in Rule 33.

Make it owner's defect if you break a lift-bar on a man's car. It now can be billed against the owner under Rule 33 if you break his grabirons due to raking and do not bring about other damage. Under Rule 32, paragraph (E), it says that if you damage any part of the car due to coupling on to it another car, then it is a delivering line defect. They conflict. What are you going to do?

J. J. O'Brien (T. R. R. A. of St. Louis): As I interpret this rule, it was to obviate the general practice of the yard men in congregating bad order cars on a specified track with couplers out. The penalization was put there in order to make you handle your bad order cars carefully.

M. E. Fitzgerald: I quite agree with Mr. O'Brien, and we mark our bill "No bill," if you please, but still the rules conflict; one rule says it is the owner's defects and when it gets to the billing office they say that we are wrong in marking it "No bill." One of those rules should be corrected.

H. W. L. Porth: I believe the simplest way to clarify that is to change Rule 33.

M. E. Fitzgerald: In Rule 33, if you damage a car by cornering or sideswiping, you repair the defects and do not have a right to bill the owner because you have brought about other damage in connection with your safety appliance. I have produced a case where I did not bring any other damage about. I merely broke the two grabirons and a lift-bar.

H. W. L. Porth: In the damage to the side ladder, that would be in connection with the sideswiping, or other defects on the car that would denote sideswiping.

Secretary Elliott: I do not agree with you. We have lots of cases where there is no other damage to the car; ladders that extend out and are fastened on with half inch bolts in the casting, are torn off and do not touch the rest of the car.

H. W. L. Porth: I think that Rule 33 should be changed. We have a lot of cases where cars are sideswiped and there is no damage absolutely to the siding. Where grabirons and ladders are damaged we have no redress.

A. S. Sternberg: Paragraph (E) is all right in the sense cited by Mr. O'Brien but it is unfair where you break a coupler in the yard under fair usage and do not have some way to get at the repair track without being penalized. I would like to see that changed something like this: "Handling of cars with broken or missing couplers or couplers out of place unless handled immediately to repair trucks."

Secretary Elliott: There is no way to check that.

Rule 33

E. H. Mattingley: It seems to me that Rule 33 should be revised to read this way:

Owners will be responsible for the expense of repairs to safety appliances, while not involved with other delivering line defects, including items mentioned in Rule 32, except damage to running boards on tank cars when sideswiped or cornered.

A motion to recommend this change was made and seconded.

M. E. Fitzgerald: I move an amendment changing it to read:

Owners will be responsible for expense of repairs to safety appliances where not involved with other delivering line damages except as provided for in Rule 32, paragraph (e), and damage to running boards on tank cars when sideswiped or cornered.

Mr. Pellien: Why not ask some one acquainted with the billing end of the rules whether or not in cases cited by Mr.

Fitzgerald, billing could be taken care of without change in Rule 32 or Rule 33?

Mr. Martin (B. & O.): I would say as far as we are concerned, if the card comes in to us marked "No bill" we let it go and do not bill them. We have no right to change marks on a repair card.

A. Herbster: Suppose a card comes to your office marked "One side ladder broken, raked," and there is no notation on it? What would you do with that?

Mr. Martin: I would mark it "No bill."

Chairman Gainey: Every car foreman in this room, if a ladder is raked off, is charging the owner of the car for it if there are no other defects. Mr. Fitzgerald is talking about the end of the car where you couple another car on to it with a chain coupler, and damage your safety appliances. He wants the rule changed to say who is responsible in that case.

Secretary Elliott: Mr. Fitzgerald has a car with a coupler pulled out. That is owner's responsibility. In handling that to the repair truck he bends two grabirons. Rule 33 refers to safety appliances where not associated with other delivering line responsibility. He has no other delivering line responsibility.

C. M. Hitch: He has the handling line responsibility when he attempts to handle a car with a missing coupler, rams into another car and damages it. That makes him responsible.

A. Herbster: Prior to the insertion of "Except damage to running boards on tank cars when sideswiped or cornered," it was admitted that the damage to tank car in cornering was owner's defect. Tank car people recognized that fact and had this clause inserted to make it a handling line's defect so they would be reimbursed. They realized that if you sideswipe a car and tear off a grabiron, that was a minor defect and the owner should stand for it. We do not want to call it a handling line defect.

Mr. Martin: The question was asked what I would do if the car was marked "sideswiped." Go back a few years when we bent grabirons and when we did not have Rule 33. Some of you remember that it was almost an endless job to have those cases settled. I think it was the intent of Rule 33 to make safety appliances an owner's defect. But there is a conflict with Rule 32 and there is no question about it.

Mr. Fitzgerald: Take a car similar to the case I cited. I am going to mark my repair card, "Caused by coupling on to car number so and so, account draw-bar pulled out." I am going to send it to the billing office marked "No bill" and the billing department is going to check on me, which all good billing departments do. They are going to say, "Why did you mark that card 'No bill'?" I will say "Rule 32, paragraph (e)." But they will refer me to Rule 33. I had no other damage on that car. They have a technical right to take that exception, as it is clearly in the rules. I want that clarified.

Mr. Owen: If you were to include paragraph (e) as suggested, you would also have to include paragraph (g), "Shifting of loads from other cars."

The motion, as amended, was carried.

Rule 43

M. E. Fitzgerald: Referring to Rule 43, I move that the foot-note be changed to read as follows:

> In the case of damage to more than five longitudinal sills on wooden underframe cars, more than four longitudinal sills on composite wooden and steel underframe cars, more than three steel longitudinal sills on steel or steel underframe cars and both steel center members on tank *or other* cars constructed with two steel longitudinal sills only, the company on whose line such damage occurred must furnish owner statement showing the circumstances under which the damage occurred, if it is claimed that the damage was the result of ordinary handling. This statement in the case of cars reported under Rule 120 to accompany request for disposition of car, and in cases where it is not necessary to report car under Rule 120 to accompany the bill for repairs, *and to be furnished on request to receiving lines when cars are offered home in interchange where no Rule* 120 *request has been previously made.*

No company, tank car or otherwise, should receive any more consideration under the rules than any other car owner. Another reason is that cars are moving in interchange badly damaged, reaching the provisions of this rule, without any protection, and there is no provision in the rule to take care of a car so offered.

The motion was seconded and carried.

Rules 56 and 57

M. E. Fitzgerald: Referring to Rules 56 and 57, I make a motion that these both be eliminated.

The motion was seconded and carried.

Rule 58

M. E. Fitzgerald: With reference to Rule 58, I move that after the words "pressure-retaining valves" the words, "release valves and dust collectors where car is so stenciled," be included, for the reason that the rule is not clear and if a brake cylinder and reservoir is missing and offered in interchange, certainly the release valve is. We should protect all of the defects that could be associated with the other items mentioned in this rule.

The motion was seconded and carried.

Rule 60

F. H. Hanson (N. Y. C.): Referring to Rule 60, I move that a paragraph be added to Rule 60 placing an age limit for the removing of air hose for the reason that a great many roads already have an age limit. They remove the hose, say, when they become three years old. Other roads, possibly private line cars, allow their hose to remain on cars, and these are now being changed by roads that have an age limit. When you make out the bill you have to camouflage it and call it something else.

The motion was seconded and carried.

Rule 68

M. E. Fitzgerald: In connection with Rule 68, I move that it be changed to eliminate reference to delivering line's responsibility in connection with slid-flat wheels. I have no objection to advising inspectors what the limit is, but I want to make slid-flat wheels an owner's responsibility. The wording should be somewhat changed in order to do that, but I am not prepared to say how. There should be some instructions as to what a slid-flat wheel is.

The motion was seconded.

Secretary Elliott: Will you include in your motion that we eliminate reference in Rule 43 to Rule 68 also?

M. E. Fitzgerald: That is taken care of automatically.

The motion was carried.

Rule 70

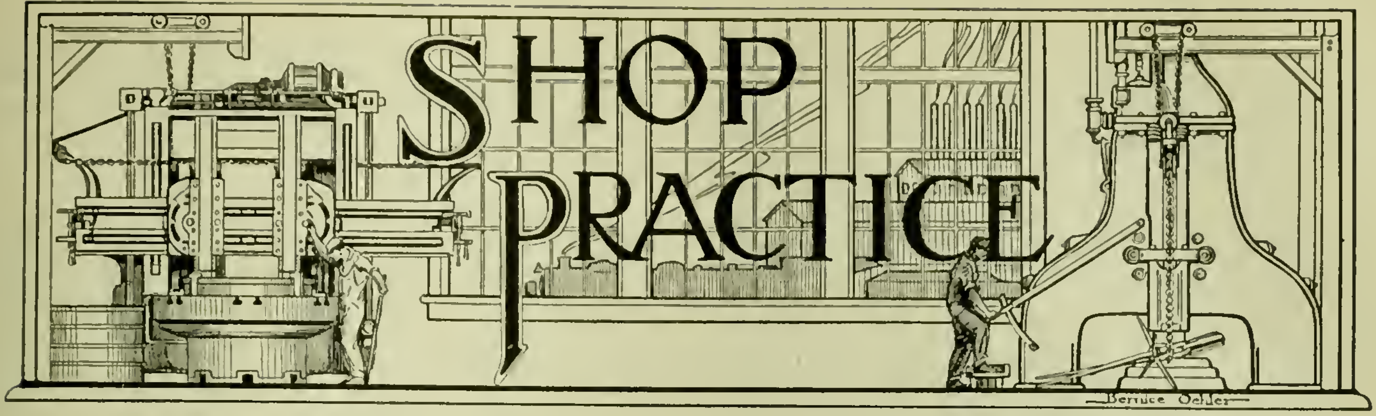
M. E. Fitzgerald: Referring to Rule 70, we have discussed the fact that defect carding for a cast wheel in place of a steel wheel is a joke. I move to eliminate Rule 70 so far as making the delivering line responsible. The owner is fully protected at the time the repair card is rendered. If you take out a pair of steel wheels and put in cast wheels, you owe the owner of the car some credit on the wheel. He has the right to get joint evidence and secure the same protection that he gets on other wrong repairs. He is not entitled to any other protection.

The motion was seconded.

F. C. Schultz: I used to feel that I could locate the man that put in the wrong wheels, but I cannot. They make changes without knowing they put them in. Inasmuch as the owner is protected, I think that this is entirely consistent.

A. Herbster: I think all of this change of wheels from rolled steel to cast iron took place during the railroad administration when no defect cards were applied. All of a sudden on a certain day the game was off and everybody commenced to slap on defect cards. That is the reason you could not locate the fellow that made the wrong repairs.

The motion was carried.



Uniform Heat Treatment of Steel*

BY H. C. LOUDENBECK

Engineer of Material, Union Switch & Signal Co., Swissvale, Pa.

To obtain uniform results in the heat treatment of steel is one of the most difficult of the heat treater's problems. Satisfactory results are dependent upon certain precautions which are often overlooked by the manufacturer. As a typical example, steel is purchased according to a specification that gives the desired physical properties when properly heat treated. The order is accepted by the steel mill and the steel manufactured and rolled accordingly. It is inspected by the purchaser's inspector who advises that it corresponds to the specification both chemically and physically and the shipment of the steel is then authorized. After it is received by the purchaser and perhaps retested, and he is satisfied that the proper heat has been shipped, it is unloaded in the stock yard either in a pile by itself or unloaded on a pile supposed to be of the same specification.

It is afterward discovered that through some error in marking the steel, it has been mixed with a heat having a different composition. The whole lot, however, has been delivered to the forge shop and made into forgings which were delivered to the heat treating plant, the results of which are obvious: irregularity, rejections, and endless trouble by the user. This is only one of the many irregularities which may be found after the steel has been received by the purchaser. For example, the steel may not be properly labeled or tagged or the tags may become lost and uncertainty exists as to the particular quality of steel stored in the yard. Again, parts of bars from the forge shop are returned to the yard, stored with steel of different composition, afterward made into forgings, the supposition being that the lot of forgings are identical in composition. From personal experience, the author is satisfied that great care should be used along these lines, especially as to the proper marking and storing of steel received in the forging yard.

What Is the Prime Requisite of a Foreman?

Must a foreman be a master craftsman in order to make good?

His job as a foreman is to inspire others and direct their efforts. He must be an executive, and, more than this, he must be a good business man, although this latter requisite is only just becoming evident in the railway operating world.

These requisites do not call for expert skill as a mechanic; they demand something very different and far more difficult.

What course should be followed in order to develop and select this kind of material for supervisory positions?

If possible, each heat should be piled separately in the yard and correctly labeled with the heat number and specification number. When this particular lot is used for the forgings intended, this heat number should follow on the forging itself. If this requirement is too great for practical forging operations, heats of similar physical and chemical properties may be segregated and given a suitable code number representing the quality of steel. For example, a steel requiring 0.40 to 0.50 per cent carbon may be divided into two grades, namely, 0.40 to 0.45 per cent carbon and 0.46 to 0.50 per cent carbon. This will enable the forger to make less changes in marking dies and will also require fewer changes in heat treating.

Another element which enters into the irregularity of heat treated forgings is the variation in the same heat of steel. For example, carbon and sulphur often vary considerably due to a segregated condition. Practically every heat varies more or less in this respect. Of course, this variation may be caused occasionally by mixed blooms of the mill but usually, it is due to segregation in the ingot which will cause a variation in the composition of the bars rolled from it. In other words, the blooms from the upper portion of the ingot will contain a higher percentage of carbon and sulphur than blooms from the lower portion of the ingot. It will be readily seen that bars rolled from these blooms will vary in proportion. A few examples on the variation of carbon in the same heat are illustrated as follows:

Size of ingot inches	Ingot No.	Heat No.	Carbon in per cent bottom of ingot	Carbon in per cent top of ingot
20 in. by 20 in.	4	4323	0.46	0.48
....	17	....	0.47	0.52
....	4	6933	0.49	0.50
....	12	....	0.46	0.50
....	5	4325	0.53	0.63
....	14	....	0.53	0.63
....	3	6934	0.45	0.53
....	1	....	0.45	0.51
....	5	4333	0.54	0.61
....	15	....	0.55	0.66
....	3	4335	0.47	0.50
....	10	....	0.44	0.51
....	4	7437	0.44	0.48
....	12	....	0.45	0.52

These are not exceptional heats. They were taken from the usual run of open-hearth practice. The ingots were cropped at the blooming mill until free of pipe as indicated by the shearing. This required from 20 to 35 per cent shear-

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*Abstract of a paper presented by title at the Philadelphia convention of the American Society for Steel Treating.

ing. Samples were taken from the upper and lower bloom after the discard had been taken. It can be seen readily that bars rolled from the upper and lower blooms would have practically the same composition as given above. The sulphur in these particular heats was quite low, running not over 0.035 per cent, usually in the neighborhood of 0.025 per cent and no great segregation was shown in this respect. It would be interesting to observe the effect of high sulphur, say 0.06 per cent in the ladle analysis in regard to segregation since many contend that sulphur running 0.06 per cent or slightly over does not have a detrimental effect on the physical properties of the steel. While this may be true, it should be considered that most specifications specify that the drilling should be taken half way between the center and outside of the bar. When this is done it does not represent the sulphur which may be segregated in the center.

Our experience has been that segregation is more liable to take place when the sulphur runs over 0.05 per cent than otherwise. It has been found that where the sampling is done according to the accepted method, a variation from 0.06 per cent, half way between the center and outside, to 0.12 per cent, when taken from the center of the bar, this steel will not make a desirable forging and will cause considerable irregularity during the heat treating process.

Irregularity in physical properties of forging often is caused by variation in size and thickness of the forging at different portions, and in some cases this is very difficult to control in order to have a uniform hardness throughout the piece. For example, an axle having a pad considerably thinner than the main body of the axle will refine and harden much stronger than the main portion. While this is overcome, to a certain extent, in the drawing operation, the final results will show considerable variation in the parts. It is difficult to overcome this and it often is necessary to draw the axle so that it will show a minimum hardness in the body in order to bring the hardness on the pad to the maximum. In other words, a study must be made of the piece to be hardened before a definite program of hardening is accepted.

By abnormal heats is meant heats of steel having the proper chemical composition, but not having normal physical properties under regular heat treating. One particular heat which contained 0.36 per cent carbon and used for axle steel was difficult to refine with the ordinary process except in very small sections. Ordinarily no difficulty was found in hardening this steel to 250 Brinell by quenching in cold water from a temperature of 1,550 deg. F. However, in this particular case the maximum hardness obtained was 185 Brinell. The analysis showed it to be normal with the exception that it contained more than traces of aluminum. The steel manufacturer may draw his own conclusion as to the finding of aluminum in steel but we cannot but think it had something to do with the difficulty in refining the steel.

In our experience, cold water should be used for quenching wherever possible as it has better penetration and gives more uniform results.

The hardness of low carbon steels, however, can be considerably raised by quenching in a caustic soda solution. The strength of this solution should be 1 to 4. We have raised the hardness of a 0.20 per cent carbon steel from 185 to 300 Brinell by means of this quenching medium. This was obtained on a section about 3 in. by 4 in. It is necessary when using a solution of this sort to use a circulating system to keep the quenching medium cool.

Where oil is used it has been found that a grade of paraffine oil having a viscosity of 190 at 80 deg. F. gives good results. This is improved by the addition of a small amount of fatty oil. The addition of 20 per cent refined whale oil gives excellent results.

This article is intended to afford suggestions of a practical nature rather than a dissertation on the fine points of the art. Of course, it is understood that it is necessary to have the proper heat treating furnace, the proper temperature control, the proper time and manner of quenching, but unless the right grade of steel is provided for the purpose and steel of uniform quality, the results will be far from uniform.

Machining Driving Boxes

Various machines have been especially equipped for the rapid machining of locomotive driving boxes and generally some type of boring and turning machine has been used. In the case illustrated, an ingenious adaptation has been made of a machine intended for another purpose. A Sellers car wheel boring machine has been equipped with a two-jaw universal driving box chuck and proves very effective for the operation of boring the crown brass and facing the hub liner.

Sellers Car Wheel Borer Equipped for Machining Driving Boxes

The boring ram has been fitted with a head carrying a single boring tool and the facing operation is performed by the side facing head. The particular advantages of the machine are the ease and rapidity of centering the box by means of the universal chuck and the fact that no re-chucking is necessary for facing the hub liner. In addition, this arrangement eliminates danger of the hub liner being out of square with the bore of the box.

Cast Iron Cutting

The possibilities in cutting cast iron with oxy-acetylene have been demonstrated at a large Indiana manufacturing plant where, in remodeling some of the powdered coal furnaces in the power plant, it was found that the cast iron floor plates for the upper deck were several inches over size and would have to be cut off. The plates had been hoisted and bolted into position at one end before it was discovered that the other ends extended over instead of resting on the center of the supporting I-beam. The attempt to correct the fault by cutting off the excess lengths with drilling tools proved very slow work and, after two and one-half days of continuous drilling, during which time gangs of brick masons and machinists were forced to wait in idleness, only two of the four plates had been cut. The two remaining plates were cut in one hour and 45 minutes by oxy-acetylene operators, using standard Oxweld type C-6 torches, the work being done accurately so that the finished plates were found to line almost perfectly with the center of the beam. The plates were 1¼ in. thick and 60 in. long, the operation consuming 310 cu. ft. of oxygen and approximately 100 cu. ft. of acetylene. An interesting feature was the fact that the cutting was effected directly over and without injury to the beam.

Fuel Economy by Accurate Valve Setting

BY J. McALLISTER
General Foreman, West Albany Shops, New York Central

The possibilities of saving fuel by properly adjusting valves on locomotives equipped with outside valve gears are not fully understood. There are three methods of squaring valves on engines equipped with these gears: first, by equalizing valve travel; second, by equalizing lead, and third, by setting valves to correct, equal piston cut-offs. The first method is the cheapest and quickest as it does not require putting the engines on rolls. It is a simple matter to make a gage that will set the crank arm to an approximately correct position. Then all that is necessary is to scribe port marks on the valve stem, trail the engine and mark the valve travel, making what alterations are necessary to equalize the travel. In the second method it is necessary to place the engine on rolls in order to check the leads which are usually squared in the full gear.

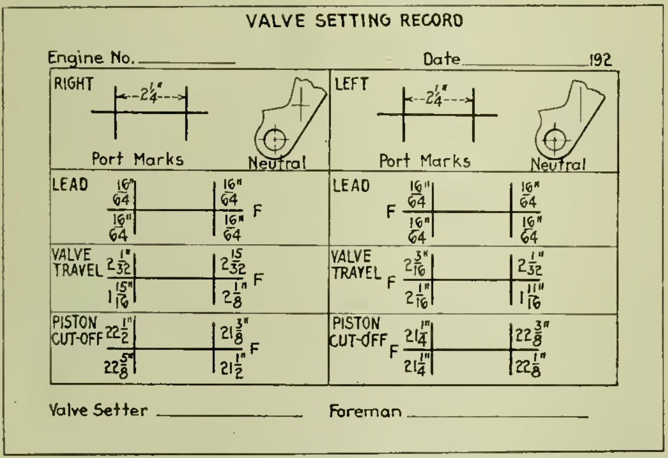


Fig. 1—Valve Events In Full Gear

The third method, although seldom used, is the only correct method of squaring valves. It is no more necessary that the ports open exactly the same distance than that they stay open the same length of time. In other words, the ports should stay open until the piston has traveled the same distance front and back, right and left.

In the third method the engine is placed on rolls with the main rods up and the lead squared in full gear as in second method, but the work is carried further: that is, the reverse lever is placed in the cut-off position (about 25 per cent), the engine run over and the piston travel measured at cut-off. Necessary alterations in the motion work will then make the piston travel the same at the points of cut-off.

It seems to be the prevailing opinion that if the valve travel or lead is equalized the other valve events will occur in regular order. Such, however, is not the case. On some locomotives, no matter how carefully the motion work is repaired and assembled, valve events do not follow in regular order.

The valve setting records shown illustrate this point clearly. These are not theoretical records, but copies of some filled out by the valve setter for an engine actually in service. Fig. 1 shows the lead, port opening and piston cut-off in full gear after alterations were made to square the lead. The lead was ¼ in. all around and attention is called to the fact that the piston travel at cut-off is one inch too great at the back end on both sides of the engine. The port openings are not at all in the same proportion.

Fig. 2 shows the events of the stroke with the reverse lever hooked up in the running cut-off position, no alterations being made. The piston travel is still about one inch too long on one side but has changed from back to front. The port openings are more equally divided.

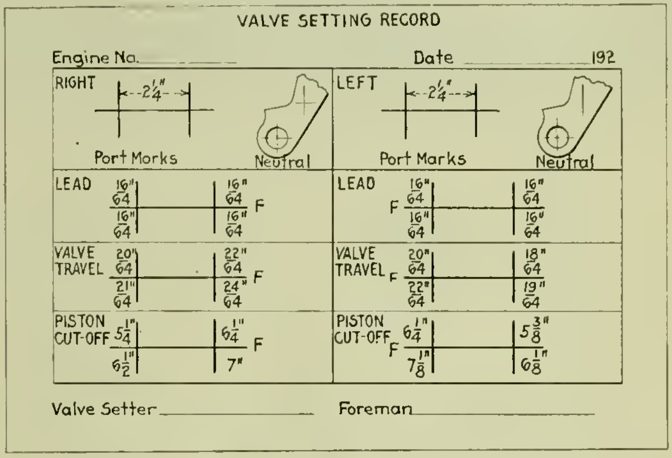


Fig. 2—Valve Events With Reverse Lever "Hooked Up"

The valve events after alterations were made to equalize the piston cut-off at 6 in. all around are shown in Fig. 3. Note the distortion of the lead, also that the port openings have crossed over, leaving the larger opening in back. This makes it evident that lead, port opening and piston cut-off do not follow in regular order.

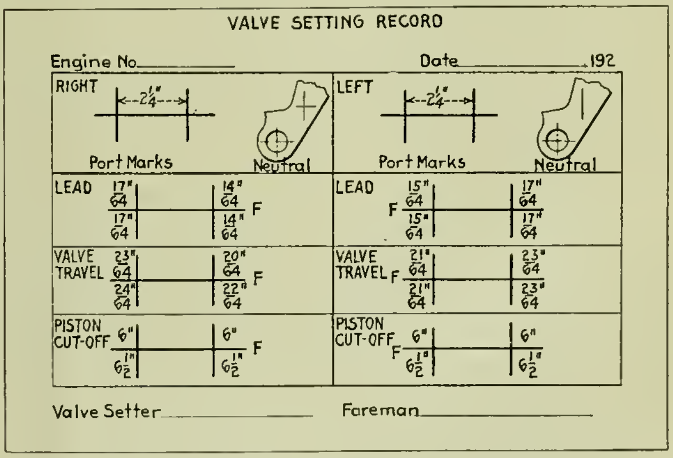


Fig. 3—Valve Events With Alterations to Equalize Cut-Offs

Unequal piston cut-offs have a serious effect on fuel economy. Assuming an engine is capable of making running time with a tonnage train at 6 in. cut-off, with valves squared as in Fig. 3, if the engine is held in shop and the leads are squared as shown in Fig. 2, the engineman cannot now make running time with the same train. The cut-offs will be at

5¼ in. and 6¼ in., and the reverse lever will have to be dropped. Assuming that the engine has either a screw reverse or a very fine tooth quadrant so it is possible to get a 6 in. and 7 in. cut-off, more steam than necessary will be admitted to each cylinder on each revolution. In other words, coal used to make that steam will be wasted and the total amount so lost in each trip will be considerable. The total amount wasted on all divisions will represent a serious economic loss to the country.

It is felt that the conditions found on this locomotive are by no means exceptional and resultant savings are large enough to warrant the most careful attention to squaring and equalizing the cut-offs in valve setting.

Some Facts Regarding Bearings

BY LOUIS A. SHEPARD

President, Hart Roller Bearing Company, Orange, N. J.

The use of ball and roller bearings which are correctly designed and accurately made in transmissions, machine tools and all machinery, subject to heavy, continuous operation is essential to reduce friction. Instances are known where the power saving over plain bearings in large factories so equipped has amounted to as much as 50 per cent, but this is exceptional. Ordinarily 15 to 25 per cent is more nearly correct. Undoubtedly there is a saving, which in medium sized factories even, is very appreciable in the course of a year and is a great help in reducing the overhead expense.

Not only is there a saving in power, but by using bearings particularly adapted to the machines, almost continuous operation is insured and the annoyance of shut downs to reline, adjust or replace plain bearings is avoided. This alone more than compensates for any increase in the first cost of application of the anti-friction bearings, for the loss of time and product is far in excess of any ball or roller bearing costs.

It is a well known fact that workmen usually do not give the proper attention to the cleaning and lubrication of plain bearings. In consequence great friction develops, the bearings burn and wear out quickly and generally require renewal at just the time when the shop is busy and machinery should operate continuously. In many cases repairs are made over the week end, but this is expensive and pay for overtime counts up rapidly. A properly designed ball or roller bearing, packed with the correct lubricant properly enclosed will operate at least fifty times longer than a plain bronze or babbitted bearing under the same conditions. This also makes a big saving in the amount of lubricating oil which must be used.

Often too little attention is given to the mounting and enclosing of the bearings, which can be so enclosed as to maintain the lubricant for long periods of time and prevent oil leaking or dripping on the floor or on material which is being manufactured. The load carrying capacity and speed of operation of ball and roller bearings exceeds that of the plain, bronze or babbitted bearings. Also ball or roller bearings having no adjustments are fool proof and will outlast other parts of the machine. In certain cases of adjustment being provided in machines the mechanism has been practically ruined by workmen tampering with such adjustments. As an additional advantage economies in space can be achieved by replacing the plain, bronze or babbitted bearings with ball or roller bearings.

In a sense the ball and roller bearing each has its particular field, yet a correctly designed roller bearing is generally superior to a ball bearing for load carrying purposes. Because of inherent features of design, a ball bearing is usually best suited to carry relatively light loads at high speeds of rotation. A roller bearing, on the other hand, is superior to the ball bearing for carrying large loads at moderate speeds and is admirably suited for installations where shock loads are encountered. A ball bearing cannot successfully absorb shock loads unless its rated capacity is far in excess of that which a roller bearing must have to carry successfully the loads occurring in the actual operation of the machine.

Given a ball of certain diameter and a roller of the same diameter with its length equal to the diameter, the roller will, for a given load, have a greater surface contact with its raceway than the ball. The direct compressive stress over this area of contact will therefore be smaller for the roller than the ball. Assuming a maximum safe working stress, the roller will safely carry a greater load than the ball at all speeds of rotation, since the drop in capacity at different speeds, due to fatigue stresses, is approximately the same for each. Size for size, made of the same material, and operating at the same speed, the roller bearing will, for a stated safe working stress, generally carry approximately 50 per cent greater load than the ball bearing. On the basis of dollars per pound capacity it is evident, therefore, that a roller bearing is a more economical installation than a ball bearing.

As the ball makes contact with its raceway under load, a certain area at the top of the ball and a certain area at the bottom of the ball, differing slightly in magnitude, will be in direct compression. The form of this surface contact area will be a warped ellipse. As a result, instead of having point contact at the top and bottom of the ball, surface contact occurs and a series of points on each side of the highest point of the ball will be touching the raceway. Since the ball should theoretically rotate about its own axis, and since the speed of rotation of a point on the periphery of the ball varies as the distance from an axis through the center of the ball, it follows that for any load applied to the bearing there will be a certain amount of slippage. This slipping tendency will further increase with an increase in load since the surface contact increases with increased load. The result is a sliding effect on the raceway which slowly but surely grinds it away. Slippage is not met with in correctly designed roller bearings. All points on the periphery of the roll necessarily have the same velocity at any stated speed of rotation of the bearing. Ball bearings are therefore limited in load carrying capacity by practical reasons in addition to the theoretical considerations already advanced.

A great many ball bearings are designed to carry both radial and thrust loads simultaneously, by employing angular contact between balls and races. Since it is a practical impossibility so to design the bearing that the velocity of each point of contact will be the same an additional spinning action is introduced.

This tendency, together with the slippage resulting inherently from any contact between balls and races, causes two different and distinct spinning effects on the raceway. For any appreciable radial and thrust load the wear and tear on the raceways is of serious import. A bearing should be designed for the performance of one function only. As one manufacturer of high grade ball bearings states in his catalogue, "radial and thrust loads cannot be carried ideally in one bearing simultaneously. Where combined radial and thrust loads must be carried, combination bearings (one radial and one thrust) assure maximum efficiency and durability."

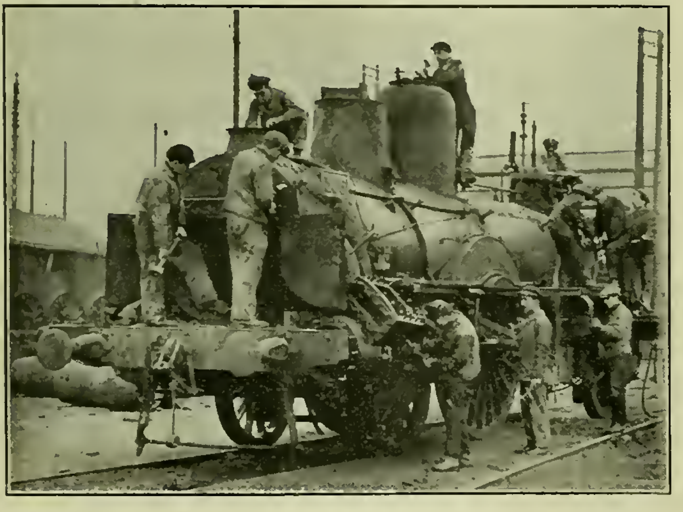
In any ball or roller bearing it is desired to obtain true rolling motion, revolution of balls or rollers around their axes in parallel planes, which means freedom from slippage and skewing and elimination of wear on parts. Load carrying capacity and speed also have to be considered. A properly designed and accurately manufactured roller bearing fulfils these requirements and becomes a money saving investment.

Paris-Orleans Apprentice Class Studying Mechanics

Paris-Orleans Apprentice Work Organized[*]

A Description of the Development of Courses for Apprentices of the Paris-Orleans During the War

THE Paris-Orleans during the war developed apprenticeship in its large repair shops and engine houses in 27 localities (37 apprentice schools). Schools at two large repair shops in Tours and Perigueux train apprentices for the various special work of repairing locomotives, cars, and trucks. Apprentices are trained at roundhouses with a view to doing repair work on locomotives and later, for recruiting as enginemen. In some exceptional cases they are also trained as boilermakers, machinists and blacksmiths at roundhouses. The total number of apprentices at these various points at the present time is about 1,200. The apprentices are given professional instruction of the widest possible range, and as wide a theoretical instruction as their intelligence and length of apprenticeship permits.



Locomotive Being Stripped by Second Year French Apprentices Before Being Taken Into Shop

The practical training is based on the following principle: "Apprentices should be watched and trained as carefully in their work as in their studies." Work which has no practical utility is reduced to a strict minimum and as soon as their professional knowledge allows the apprentices undertake practical work. The result of this method is to interest the apprentice who, knowing that he is doing useful work, puts more energy into it. He is paid from the start, being employed on useful work, and this helps lighten the burdens of his family.

The theoretical training consists of French classes, arithmetic, geometry, physics, mechanics, drawing and technology classes which occupy the apprentice about six hours a week.

Terms of Admission

The age of admission is between 14 and 17 years, according as the candidates are or are not holders of a certificate for primary studies. However, in the case of young men with a higher education (pupils of secondary schools) the age limit of 17 years may be raised. Apprentices answering to the above conditions and who have made a request for admittance, signed by their parents, either to the chief offices of the company or to the staff department in Paris are called to undergo a medical examination and a short entrance examination composed of: Dictation of 20 lines, with some grammatical difficulties; problems on the four rules and on one question of surface and volume; division of whole numbers, with proof by multiplication; reading.

After this examination, the candidates who have passed the medical examination are classed in order of merit and admitted according to the number of places vacant. Preference is given to sons or relatives of employees, to children of large families and to apprentices who already have some knowledge, that is, who have taken the pre-apprenticeship classes or supplementary classes.

Every boy binds himself to finish his apprenticeship in the establishment and the trade where he began and to remain in the company until his military service. An apprenticeship contract to this effect is signed jointly by the boy

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[*] Translated and abstracted from an articles by M. Lacoin, chief assistant engineer, and M. Chassagne, mechanical engineer of the Paris-Orleans, in the August, 1920, issue of the Revue Generale des Chemins de Fer.

and his parents or guardians. The penalties for breaking this contract are: non-payment of the cash prizes mentioned below, which are normally paid at the end of the apprenticeship; proceedings against the parents or guardians for damages or injuries caused to the company by the apprentice leaving.

The number of apprentices in each establishment is regulated so that the total number of apprentices and workmen who are minors, does not exceed 25 per cent of the adult staff of workmen in any shop. Each apprentice remains on an average five years in the establishment before his military service. The number of apprentices admitted each year is therefore, on the average, five per cent of the strength of the adult staff of workmen in the establishment.

Instruction of Apprentices

The instruction given to apprentices consists of a professional manual education complemented by theoretical explanations, arithmetic, drawing and spelling, which last for about six hours per week. Wherever possible, apprentices are grouped in the workshop under the supervision of an instructor who is thus enabled to direct the instruction of 10 to 15 apprentices.

The employment of a single instructor has the advantage of allotting to this post the best qualified workman and gives to the new apprentices a single plan of work, which depend upon the instructor's qualifications. It also permits of more individual instruction, the apprentices being taught orderly habits of work and good conduct.

As far as possible, an instructor is chosen who is able to direct practical and theoretical instruction of the apprentices at the same time, thus maintaining a constant connection between the two branches. This object has been attained in some shops, but it is difficult to find teachers who unite practical and theoretical knowledge and in some large centers special teachers have been employed for the theoretical classes, keeping in as close touch as possible with the practical instructors.

Apprentices in Enginehouses

The program of practical instruction in the engine houses is slightly different from that in the repair shops because the former are only called upon to train engine fitters who can later become engine drivers and directors of repairs to locomotives.

The apprentice school program of the enginehouses is as follows: *First year.*—Half the day, the morning by preference, is devoted to methodical and progressive practice in fitting and to theoretical classes (18 hours fitting, and six hours of theoretical classes per week). The rest of the day is taken up by practical work in the repair of detail parts. The program of progressive exercises to be carried out by the apprentices is given in a book of machining notes and includes a course of work of about 10 months on the average. To complete the first year of practical instruction, apprentices who have performed their progressive exercises well are given supplementary exercises chosen from the following work: making or repairing face plates, V-ways, shifting-gages, various keys, screw and case dies, hammers, graving-tools, chisels, spanners, etc. Drilling machines, pneumatic hammers, parts of machine-tools in the workshop, etc., are overhauled and repaired.

Second year.—In the second year the apprentices cease to be systematically employed on the vise. The "mounting" apprentices are, wherever the number makes it possible, grouped in special gangs aided by one or two chosen workmen and a small number of laborers.

Thus organized, they carry out in its entirety the half-yearly and yearly repairs to simple locomotives or in some cases to compound locomotives, including the fittings, cocks and valves. This arrangement makes them learn all the work of mounting while preventing them from being employed as minor laborers, as is too often the case when apprentices are placed in a gang of workmen.

In localities where this arrangement cannot be carried out the "mounting" apprentices are either united with the third year apprentices or with the minor workmen to form a special gang under the conditions mentioned above, or grouped under the direction of an instructor to make part of a repair gang. They are not placed alone in the gangs even with a good workman. By isolating them in this way there is too much risk of making lesser hands of them, whose professional training would be mediocre.

The instructors see that they do not do work which is beyond their strength, and make each apprentice take the different places in the gang so that they do not specialize.

First Year Apprentices in Fitting Shop of Paris-Orleans

Third year.—In the third year the apprentices are still supervised and like those of the second year are grouped in special gangs under the direction of a chief mounter or chief of a group and carry out the half-yearly and annual repairs to locomotives, modern ones by preference, taking the place of the ordinary gangs entrusted with these repairs. In establishments where their number is small, they are united under the supervision of the chief of a group of men who have just finished their apprenticeship, thus forming a special gang. The best third year apprentices are made use of as monitors in the second year gangs.

In the course of the third year the apprentices also take in rotation a course of one month each in the forge, boiler and machine shops respectively. These courses, the program of which is drawn up in the beginning of the year, are described in a special notebook so that their proper execution can be checked by the inspectors. After completing the course, apprentices in roundhouses have a knowledge of locomotives which is a great aid in helping them to qualify as firemen and later enginemen.

Apprentice Work in Repair Shops

The program of practical instruction in the repair shops is as follows: apprentices (except those in wood-working, painting, upholstering and molding, who are few in numbers, and who begin immediately in their respective workshops) are placed in a school for iron-workers situated in the fitting shop. In this school they follow a program similar to that for apprentices in the enginehouse, and their time is divided between study and practical work. After six months they take a professional examination, the result of which is taken into account in deciding their definite distribution among the classes of mounters, fitters, machinists, boiler-makers and blacksmiths. In this distribution the physical aptitudes and tastes of the apprentices are also taken into account. The classification once made, the fitter and mounting apprentices remain in the iron-workers' school where they follow an identical program to that of the apprentices in the enginehouse. The boiler-maker apprentices and the blacksmith apprentices are placed in two special schools where they follow practical courses extending over a year.

The instruction given in the boiler-makers' school includes: a knowledge of descriptive geometry necessary for tracing the intersection of solid materials; tracing of sheet-irons in general; finally, the manual work of a boiler-maker.

The instruction given in the blacksmiths' school includes the theoretical rules for blacksmith modelers, the rules of soldering and the general work of a blacksmith.

After a year in the special school, that is to say about 18 months in the company, the boiler-maker and blacksmith apprentices are considered to have finished the special courses necessary to a knowledge of their trade and are placed in the boiler-makers' and blacksmiths' workshops where they do only practical work under the direction and with the advice of experienced workmen.

Theoretical Instruction

The theoretical instruction of shop apprentices covers three years. In the second year the apprentices revise the work already studied in the first year, and in the third year they take a special course of technology. Experience has shown that this procedure gives good results and has moreover the advantages of facilitating the organization of the classes.

Theoretical classes are held every year from October 1 to July 31. They last for six hours a week during the two first years at the rate of four sittings of about one and one-half hours, and only one and one-half hours per week in the third year.

The total number of instructors is 47 and the classes they teach are in addition to their normal work. They are distributed as follows: master mechanics, three; foremen, six; checkers, sub-inspectors, two; assistant foremen, ten; heads of gangs, nine; workmen, two; employees, 15, six being ladies.

First Year Apprentices in Forge Shop

Instruction is by means of specially written elementary courses drawn up by a central department and distributed to the instructors and to the apprentices. Abstract methods of explanation are avoided by referring to the various operations and apparatus used in the workshops and conducting demonstrations with the apparatus itself. The explanation of the lesson is aided by frequent questions to the pupils, followed by a short résumé.

The first and second year courses, which are the same, include 170 lessons in general technology, drawing and sketching, French, arithmetic, elementary physics and mechanics. The third year apprentices have at their disposal a course of study in technology including 40 lessons, one per week affording an elementary knowledge of the locomotive. This instruction is given in the form of appendices, the details of which are given below:

Appendix 1.	Boiler	6 lessons	30 lessons
Appendix 2.	Wheels, frames, suspension	4 lessons	
Appendix 3.	Parts, motors, arrangement of mechanism	15 lessons	
Appendix 4.	Various parts, special devices, tender, boiler, work and reading of graphs and diagrams	5 lessons	

These lessons are given by means of sketches, demonstrating apparatus and the parts of the machines themselves, either in the lecture room or in the workshop.

In the course of the three years the apprentices take oral and written examinations at the end of every half-year, in order to show the progress made. These also serve as a basis for proposals for increase of wages and bonuses, which are mentioned further on.

The apprentices' instruction is also at all times checked by means of questions put by foreman and higher agents of the central department on their rounds in the instruction centers. This checking of the apprentices' knowledge is also a check of the teaching given by the local instructors. Instructors should realize that technical instruction is only one part of the professional training, and that it is equally important to instil into the apprentices habits of discipline, order, method, self-respect, in a word, give them a moral training.

Competitions and Remuneration

Competitions are arranged at the end of the first year's apprenticeship after the half-yearly examinations, among the best students in the various shops and roundhouses of the company. At the end of these competitions there is a distribution of prizes, books and instruments, to the prize-winners. At these distributions, apprentices who have satisfactorily finished their apprenticeship receive a savings-bank book in which are inscribed the amounts of the various half-yearly bonuses accorded during the course of their apprenticeship, and an "end of apprenticeship" diploma.

The apprentices commence work at 25 cents, 30 cents or 35 cents per day, according to their value and their age, with successive increases based on the results obtained during the course of the apprenticeship. The apprentices may, therefore, attain at the end of their three years' apprenticeship, a daily wage equal or superior to that of the best junior workmen in the shop. They also draw special allotments on account of cost of living and residence, and those who have had more than 18 months' apprenticeship receive a premium of 10 cents per working day.

In order to interest parents in the children's work, the apprentices' progress is shown every month in an individual notebook in which is recorded professional skill, theoretical instruction, conduct, money advances allotted, and money drawn. This notebook is signed by the officer in charge of the apprentices who writes in it any observations he thinks it useful for the parents to see. The latter also sign this notebook after having noted each month the remarks made therein. The parents are also directly communicated with when their son does not give satisfaction in his work or his conduct, and are advised of all punishments he undergoes.

Second Grade Apprentices

Those young men who, in the course of their first year of apprenticeship, show that they are capable of attaining a higher degree of efficiency than the average, are allowed to follow extra classes called "second grade," which last three years. These young men have a special contract with the company signed by them or their parents or legal guardians.

A résumé of the second grade classes is given below:

Theoretical Second Grade Classes

First Year

1. Arithmetic.
   Algebra (functions of equation of the 2nd degree).
2. Geometry, plane and solid.
3. Mechanics (elements up to the determination of the centre of gravity).

Second Year

1. Mechanics (static and dynamic).
2. Physics.
   The Steam Engine.
3. Geometry, ordinary graphs.
   Descriptive Geometry (elements).
   French.

Third Year

1. Mechanics—rudiments of resistance of materials.
2. The Locomotive.
   Internal Combustion Motors.
3. Descriptive Geometry, drawing.
4. Electricity.
   Chemistry (rudiments).
5. Rudiments of political economy.
   French.

The second grade courses are carried on by means of correspondence. The pupils belonging to the different shops of the company receive the necessary directions for their studies from the chief agent and four assistants in charge of this course of instruction, who reside in Orleans. A summary of the lessons to be learned and instructions as to the works and pages to be consulted is sent to apprentices on Friday of each week. They have to make a résumé of the lessons learned in this way in a special exercise book, and this book is sent every two months to Orleans to be examined.

Second grade apprentices only study in common with their companions of the first grade, the technology and drawing classes. But so as to facilitate the study of the second grade program, three periods of study per week of 1½ hours each are given. These take place preferably during the time of the French classes, calculation, geometry and first grade physics, which they do not attend. It is necessary for them to complete these studies by private study outside of working hours.

An examination is held every six months, on the subject matter studied during the previous half-year. It includes written tests followed by oral tests. These oral examinations take place before a special commission which visits the principal centers where the pupils are grouped. They test by the questions put how the pupils are assimilating the knowledge which is being given to them by correspondence, and take advantage of this meeting to complete the knowledge required, explain and clear up the points which are obscure. At the end of the year, the best pupils receive prizes like the first grade apprentices. There are 32, 22 and 30 second grade apprentices in the first, second and third years respectively.

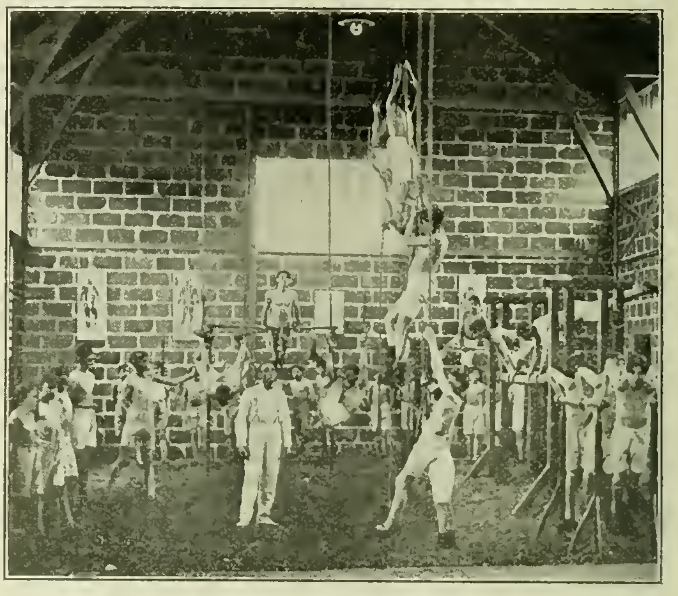
Physical Culture

With the object of improving the physical development of the young men, the company encourages an interest in sport among its staff, and especially among the apprentices. The heads of local departments take an interest in the work of physical development and to this moral aid is added pecuniary aid consisting in annual subscriptions to the sports associations formed by the employees of the company. At present there are nine associations of this kind. The company has, moreover, furnished a room in the repair shops at Tours and Perigueux, and organized classes for physical development for apprentices of less than 18.

Results Obtained

One of the greatest obstacles which is encountered in apprenticeship is the instability of the apprentices. They leave their employers as soon as the apprenticeship comes to an end, and even during the course of the apprenticeship. As a matter of fact, the wastage, which was fairly large before the reorganization of apprenticeship on the Paris-Orleans, has considerably diminished. The way in which apprenticeship is made to lead directly to the railway trade, and the various bonuses which are only paid at the end of the period of apprenticeship have a good effect. At the last promotion the wastage at the end of the third year did not exceed one per cent.

The apprentices who have followed the complete course after reorganization are sufficiently numerous to allow of estimating exactly the value of trained workmen. They have shown themselves clearly superior to the average of the workmen who were engaged before the war after military service. The output of the gangs of second and third year apprentices is excellent. As the total number of apprentices was 1,200, it may be hoped that the former apprentices will in future form the nucleus of the whole working staff, and that a very appreciable rise in professional and technical value will result.



Gymnasium for Apprentices on the Paris-Orleans

The second grade apprenticeship has shown each year about 30 young men who are of clearly superior capacity to the average and anxious to improve their knowledge. The second grade work, which is done outside the hours of manual labor, requires much energy and tenacity on the part of the apprentices. It may therefore be hoped that the old second grade apprentices will have the energy, and assure the basis of recruiting for head workmen, foremen, chief mechanics, and a part of the chief assistants in the shops, and that the result will be a still greater improvement of the average professional value among this class of employees.

It would be interesting to estimate the economic output of the organization apprentice which is, however, difficult to do with exactness on account of the complexity of the problem. The wages paid annually to the apprentices are about 3,500,000 francs. The general cost of the instruction is about 100,000 francs. The machinery which the apprentices repair is at a standstill a little longer than that which is repaired by regular gangs of workmen and this concludes the debit side of the apprenticeship account.

The credit side is more difficult to establish. The work done by the apprentices is in the first year very decidedly below the cost of the apprenticeship. In the last year the situation is reversed. On the whole, it seems that the value of the work produced corresponds very well to the cost of apprenticeship. We may therefore consider that the improvement of facilities for recruiting and developing valuable employees will be a clear profit.

Four Efficient Santa Fe Machine Shop Devices

Too Much Attention Can Hardly Be Given to Jigs and Fixtures Which Really Save Time or Labor

BY J. ROBERT PHELPS
Apprentice Instructor, Atchison, Topeka & Santa Fe, San Bernardino, Cal.

IT is often possible by the use of comparatively simple jigs or shop devices to extend either the range or kind of work performed on machine tools, the following devices having been developed and tried out with good success at the San Bernardino shops of the Atchison, Topeka & Santa Fe.

Turning Bevels on a Boring Mill

A device, used on a boring mill when cutting bevels or slants, as found on piston valve spiders, followers or bull rings, is illustrated in Fig. 1. A lathe may not always be available for this work and in a certain case a large number of spiders and followers had to be turned on a boring mill. As the mill feed forced the tool out, it was necessary for the machine operator to maintain the down feed by hand, just enough to give the piece being machined the desired taper. In order to tell when the down feed was correct, the device illustrated was developed.

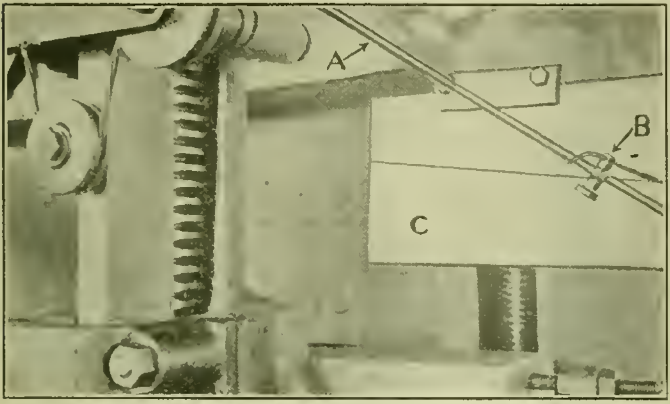


Fig. 1—Bevel Indicator Applied to Boring Mill

A 5/16 in. round steel rod *A* is electric welded to a rod key base plate approximately 5 in. by 2 in. by 5/8 in. To add stiffness, a shorter electric welded rod extends from the base plate to the initial rod at a point about 12 in. from the base. The base plate is fastened to the top of the boring mill tool bar by means of two 3/8 in. cap screws through suitable holes in the base plate, a standard surface gage scriber *B* being slipped on over the 5/16 in. rod. A piece of sheet iron *C*, chalked or white washed is secured to the frame of the boring mill as shown, and a line drawn on it at the required slant or angle which it is desired to cut. With this arrangement it is comparatively easy for the machine operator to feed the tool down by hand just fast enough to keep the point of the scriber on the line. The principle can also be readily applied in machining to an irregular line.

Removing Lathe Chucks

The method of swinging a lathe chuck out of the way to make room for a small job between the centers is illustrated in Fig. 2. On this particular lathe, it is often necessary to take off the chuck several times a day. With the arrangement shown a right angle arm *A*, arranged to swivel, is secured by means of brackets to the back of the lathe. Rod *B* with an adjusting nut on the top and a threaded lower end passes through a hole in arm *A*. The chuck is drilled and tapped to receive one end of rod *B* which has been previously threaded.

In operation, the chuck is loosened on the lathe spindle and the bolt *B* is turned into the chuck, the adjusting nut at the top being tightened until all slack is taken up. The lathe is then run back either by hand or power and the chuck comes off and can be readily swung back out of the way. After the job between centers has been done, the chuck can be swung forward and easily re-applied. This arrangement makes it possible for one man to handle a heavy chuck easily and in addition the chuck is kept off of the floor where it would be in the way and accumulate dirt.

Combination Square Attachment

An attachment to be used on a combination square in setting up driving boxes for boring is illustrated in Fig. 3. It is essential that the boxes be bored parallel with the shoe and wedge faces and at right angles to the hub faces. This device affords a convenient and effective means of checking the driving box set up.

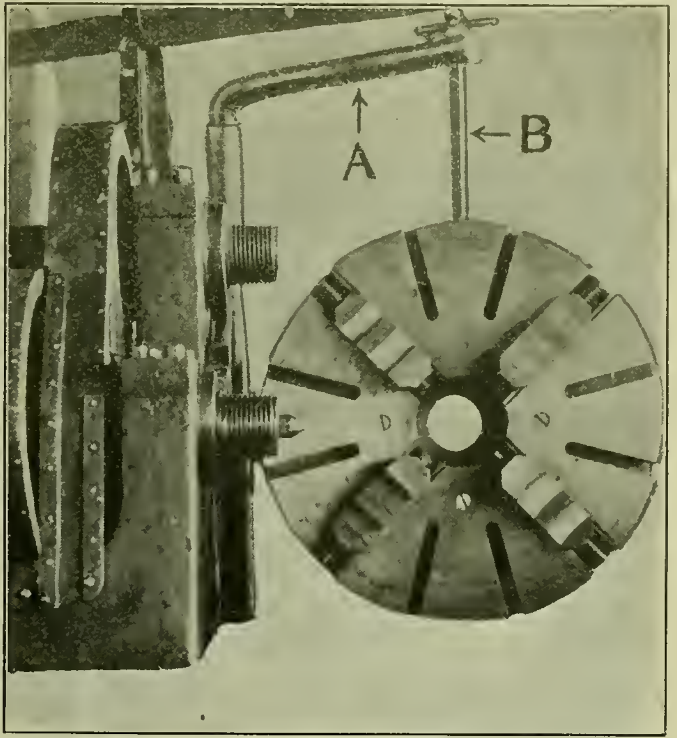


Fig. 2—Swinging Arm Facilitates Removal of Chuck from Lathe Spindle

As shown in the illustration, the device is simple and consists of a piece of sheet metal drilled with five holes to reduce weight and attached to a sliding head which may be held in any position on the scale by means of a thumb screw. The plate reaches over the driving box flange and makes it unnecessary for the operator to caliper from the scale over to the shoe and wedge way. He can tell at a glance whether the box is set up so that the bore will be parallel with the shoe and wedge. Approximately 180 boxes a month are being machined at this point and while this device saves only about three minutes on each box, the total saving in time is important. In addition the device makes possible more accurate work.

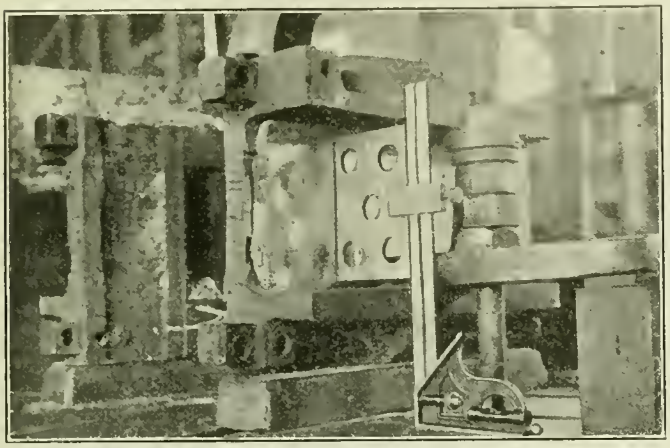


Fig. 3—Combination Square Attachment Aids in Setting Up Driving Boxes

Extension Table for Milling Machine

In cases where it is desired to perform a small milling machine operation on the end of a shaft or long machine part the extension table and V-blocks, illustrated in Fig. 4, can be used to good advantage, saving a considerable amount of time in setting up and assuring an accurate job. As shown, a slot is planed in this extension table or plate square with a rib on the under side so that in applying the plate all that is necessary is to tighten up two ⅝ in. by 2½ in. bolts to have the table square. Two V-blocks are arranged to slide back and forth in the groove as shown so that they will be square with the table in any position. This device opens up the machine to a much wider range of work, as for example the boring and facing of rocker arms on the boss ends and other similar machine operations.

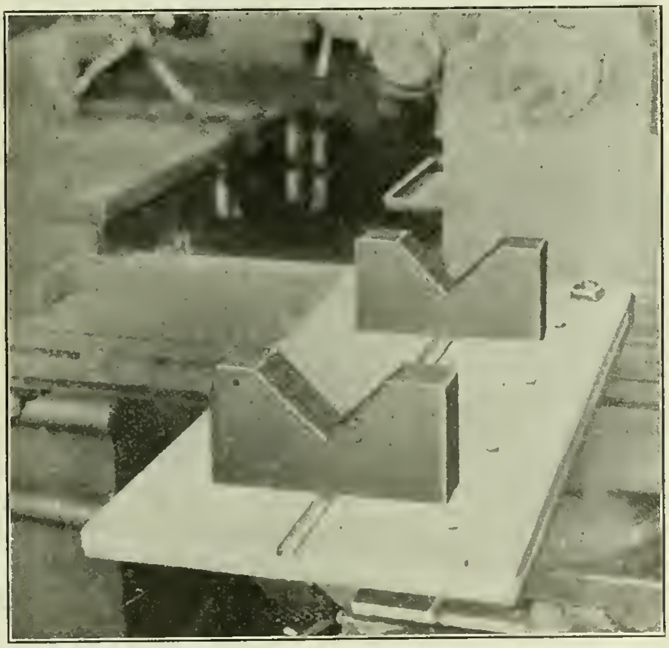


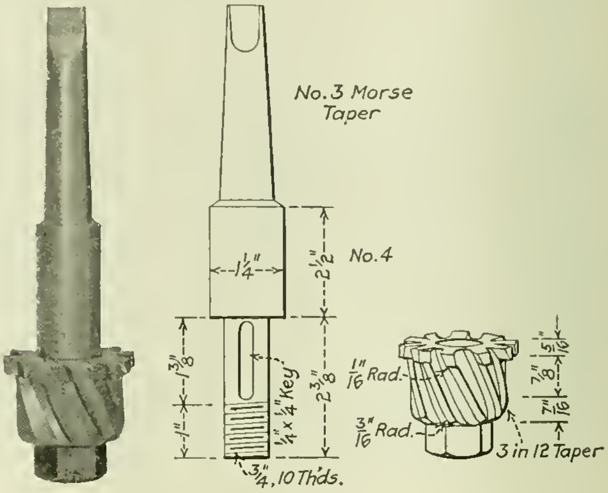
Fig. 4—Extension Table and V-Blocks for Milling Machine

Reaming Tube Sheet Holes

BY GEORGE BREXTON
Tool Foreman, Grand Trunk Shops, Stratford, Ont.

For the rapid and smooth reaming of tube sheet holes, the tool illustrated has been found very satisfactory. Reamers formerly used for this work consisted of a roughing reamer of the shell type and a straight flute, finishing reamer for finishing. The roughing reamer had a taper of ⅜ in. in 12 in., but was found to be useless in the hands of a careless operator owing to the fact that there was no gage to indicate the size of the hole which, in many cases, was made larger than necessary. In addition, the long, spiral flutes caused a great deal of difficulty from sticking. The objection to the straight flute finishing reamer was the leaving of chatter marks and the necessity of changing from a square to a No. 3 Morse taper socket.

The new reamer, illustrated, is designed to perform both operations of roughing and finishing. It is made of Mushet high speed steel having a radius of ⅜ in. on the bottom cutting edge enabling it to remove rapidly any ragged edges or marks left by the ripping tool. A taper of 3 in. in 12 in. is provided on this reamer for a distance of 7/16 in. as indicated. This tapered section rounds out the tube hole and the ⅞ in. parallel cutting edges finish it to the correct size.



Reamer for Roughing Out and Finishing Tube Sheet Holes

A round filleted shoulder at the top removes the sharp edges on the tube sheet and prevents the copper ferrules from being cut in the process of beading or expanding. The reamer is detachable from its spindle as shown in the illustration, being held from revolving by a ¼-in. key. The spindle is machined to a No. 3 Morse taper. On account of the removable feature, the reamers can be changed easily from one size to another with the aid of a short ¾-in. spanner or wrench to tighten the holding nut.

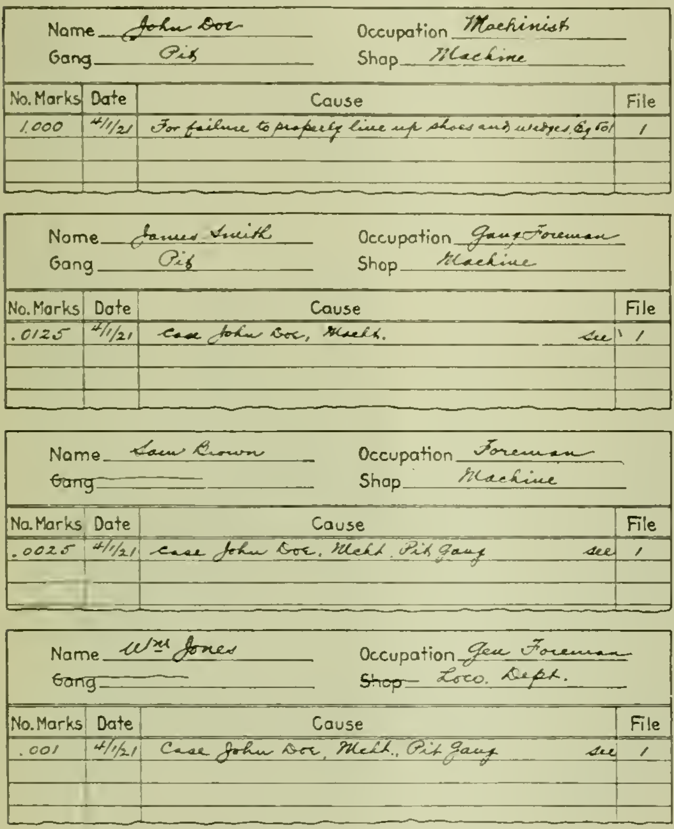
Protecting Metals at High Temperatures.—Calorizing as a means of protecting metals exposed to high temperatures is discussed in an article by Arthur V. Farr, recently published in the *Iron Age*. The treatment fuses aluminum into the exposed portion of the metal so as to form a homogeneous aluminum alloy for a certain depth, ranging from a few thousandths of an inch to the permeation of the entire mass. The formation of the oxide, alumina, prevents the penetration of oxidizing gases. The aluminum oxide surface must be preserved unbroken, and for this reason, machining is best done before the calorizing process. Calorized parts have been successfully used for carburizing and annealing boxes, pyrometer protection tubes, stoker parts, conveying apparatus, for furnace linings and baffle plates.

A System of Progressive Shop Discipline

Foremen and Men Are Held Accountable for Mistakes In Proportion to Their Individual Responsibility

BY GRANT GIBSON

An editorial published in a recent issue of the Railway Age contained the following statement: "The selection of men for prospective foremen should not be left to chance, as past experience has amply demonstrated the possibility of keeping personal efficiency records whereby the master mechanic or shop superintendent is enabled to tell at a glance which one of his employees will probably best fill a vacancy among the foremen."



Name John Doe Occupation Machinist
Gang Pit Shap Machine

No. Marks	Date	Cause	File
1.000	4/1/21	For failure to properly line up shoes and wedges, Eg. 701	1

Nome James Smith Occupation Gang Foreman
Gang Pit Shop Machine

No. Marks	Date	Cause	File
.0125	4/1/21	Case John Doe, Mach. see	1

Name Sam Brown Occupation Foreman
~~Gang~~
Shap Machine

No. Marks	Date	Cause	File
.0025	4/1/21	Case John Doe, Mach. Pit Gang see	1

Name Wm Jones Occupation Gen Foreman
~~Gang~~
~~Shop~~ Loco. Dept.

No. Marks	Date	Cause	File
.001	4/1/21	Case John Doe, Mach., Pit Gang see	1

Fig. 1—Card Form for Individual Records

The above statement is true and there is no reason why efficiency records should not be maintained in railroad mechanical departments, as well as in transportation departments where the Brown discipline system is generally adopted. The latter system shows the merits and demerits of employees in the transportation department and the superintendents have little difficulty in selecting the right men to fill vacancies in the ranks of the supervisors.

In railroad shops in the past personal feelings, or the foreman's recollection of a man's past performance often decided who should be promoted. More recently the question was settled by seniority rules and irrespective of ability. Both of these methods are decidedly inefficient and it is, imperative that, to promote men intelligently, personal records must be maintained. The system proposed in this article will also result in checking up the ability of gang foremen, shop foremen, and general foremen. It is just as essential to maintain an efficiency record for the man who is now supervising as it is for the workman who will eventually be a supervisor. We want to know how efficient the gang foreman is in supervising his men because he may be needed as a shop foreman. Similarly, the shop foreman should assume a just proportion of the errors made by his gang foremen and the men working under them.

In other words, the supervisory force should be assessed for all mistakes, careless or otherwise, that occur under their jurisdiction as after all they too are responsible. Give them a black mark for these errors and it won't be long until those who are responsible for repeated demerit marks will show improvement or be released.

Numerals can be used to designate demerits, one demerit mark for a casual incident, two for one of a semi-serious nature and three for a serious one. It is necessary to designate a maximum number of marks in a given length of time to cause dismissal. For example, any employee who might get fifteen demerits in one year would automatically dismiss himself from the service. On the other hand, a clear record over a given period should eradicate a certain number of marks. The following is an outline of fundamental suggestions, the finer points of which could be easily worked out to fit local conditions.

In order that the system be equitable, a gang foreman must not be assessed one full mark for each mark given one of his men as ere long a gang foreman with a number of men would soon reach 15 marks and be out of service. Neither should a gang foreman handling forty men be assessed as heavily as one handling twenty men as in the first instance the foreman has a greater number of men to watch and, therefore, is up against a greater hazard.

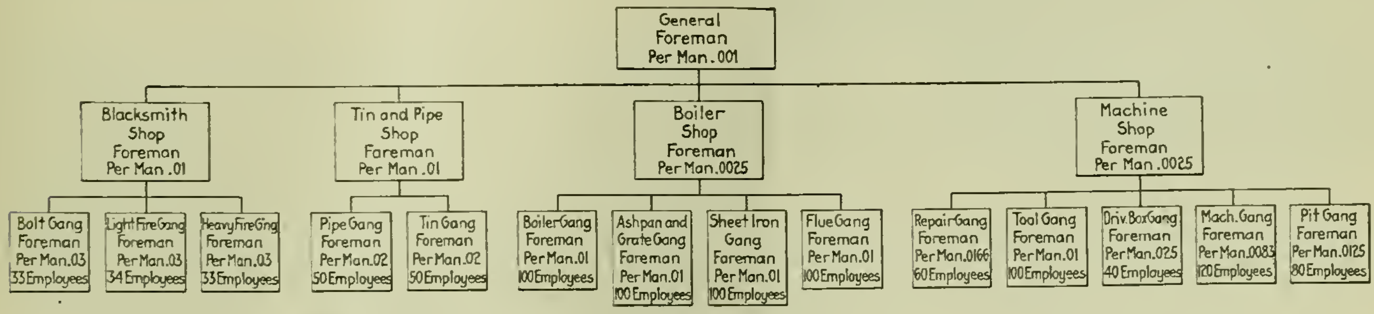


Chart 1—Percentage Demerits Charged Against Gang, Shop and General Foremen

The solution is to assess in percentages. The individual who makes the mistake is given one mark and his gang foreman is given a percentage of one mark based on the number of men in the gang. Chart 1 is an example of this percentage system and is based on a locomotive department employing 1,000 men. Note that the gang in the right block (pit gang foreman) consists of 80 men. Divide 1.000 by 80 and the result is .0125. The machine shop foreman has jurisdiction over 400 men. Divide 1.000 by 400 and the result is .0025. The general foreman is responsible for 1,000 men and should be charged with 1.000 divided by 1,000, or .001. Therefore, should one mechanic in the pit gang make an error, that calls for record discipline, he would be assessed 1.000 mark; his gang foreman .0125; the machine shop foreman .0025, and the general foreman .001.

It will, of course, be necessary to institute a card form for this individual record and Fig. 1 illustrates such a form and the entering of an error which affects the individual record of the four men as previously explained. These cards should be filed alphabetically in the general foreman's office. A file would have to be inaugurated to fit this system, arranging it numerically and giving the first case File No. 1, etc. Notification in writing of the individuals concerned is only fair so that their attention may be called to any black marks on their records. At the end of each month, the several cases of demerits should be summarized and bulletins posted covering them, leaving out the name of the individual concerned.

The principal virtue in this idea of progressive discipline is in the fact that the man higher up cannot overlook careless employees as his record suffers by reason of the mistakes of subordinates. If there are two or three marks on a foreman's record caused by the carelessness of one man, he is certainly going to keep his eye on this man and put the machinery in motion to educate him or else show cause to dismiss him.

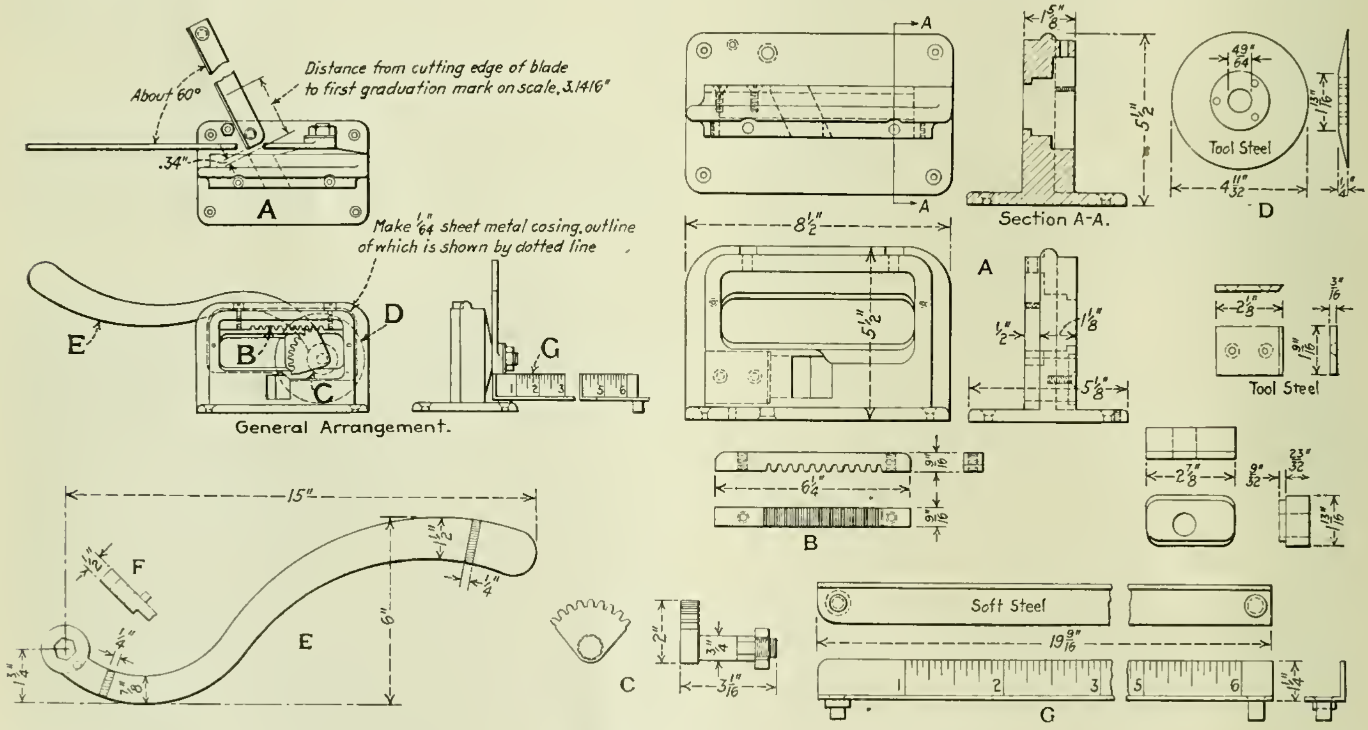
Second, a progressive discipline system as proposed would make it simple for a general foreman to make his recommendations to the master mechanic to fill a vacancy as a gang or shop foreman. If, for example, he needed a machine shop foreman an examination of the discipline cards of gang foremen would show the best man at a glance.

Another quotation from the Railway Age reads: "It is difficult to find an argument not already advanced for the more careful selection and training of railroad shop foremen." The proposed system of progressive shop discipline would do much to facilitate both the selection and training of shop foremen.

Soft Packing Cutter

BY NORMAN MACLEOD

Much waste in cutting fibrous packing for globe, angle, blow-off valves and miscellaneous valve stems can be eliminated by the use of a cutter which has been designed and proved satisfactory in one of the large shops of a prominent railroad. Details and the general arrangement of the cutter are shown in the illustration. The cutter consists of a frame *A* bolted or screwed to a work bench. Attached to the frame is a rack *B* in which is engaged a quadrant gear and shaft *C*. A circular hardened steel cutter *D*, operated by handle *E*, is slipped on shaft *C* and moves with the quadrant. Stop *F* regulates the throw of the quadrant.

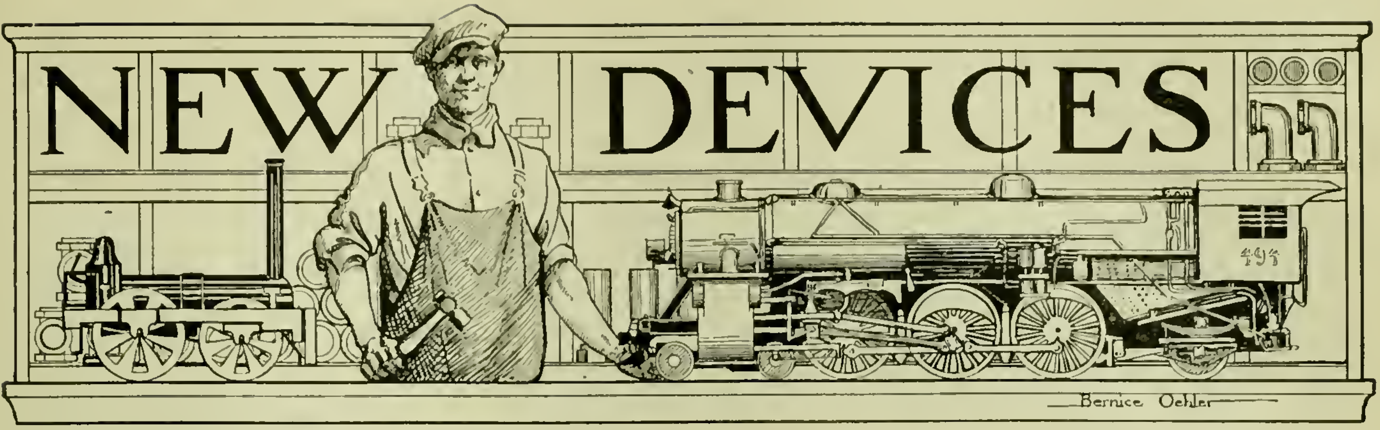


Details and General Arrangement of Soft Packing Cutter

Attached to the frame proper is a graduated gage *G*, the scale of which is marked for the various diameters of rods, in this case the graduations varying up to 6 in. in diameter. This gage is preferably made of an angular section to allow the packing to be held firmly and squarely while it is being cut.

Operation of the device consists in placing the packing through the opening in frame *A* provided for the purpose and cutting off one end, which will be at about 60 deg. according to the angle of the gage. The packing is then pushed on through until its extreme end coincides with the figure or graduation on the gage which represents the diameter of the rod for which the piece is intended. An overthrow movement of the handle gives the steel cutter a circular and also, with the rack and quadrant gear, a horizontal movement which carries the cutter through the packing.

The gage being set at an angle of about 60 or 65 deg. the ends of the packing are cut at such a bevel that when it surrounds the rod a tight joint is made.



Special Railroad Draw-Cut Shaper Attachments

THE special railroad draw-cut shaper, as finally developed by the Morton Manufacturing Company, Muskegon Heights, Michigan, is a heavy duty production tool capable of performing a large variety of machine operations in railroad shops. Owing to the fact that the cut is taken on the return stroke of the ram, deep cuts can be taken with coarse feeds and smooth, accurate work is assured.

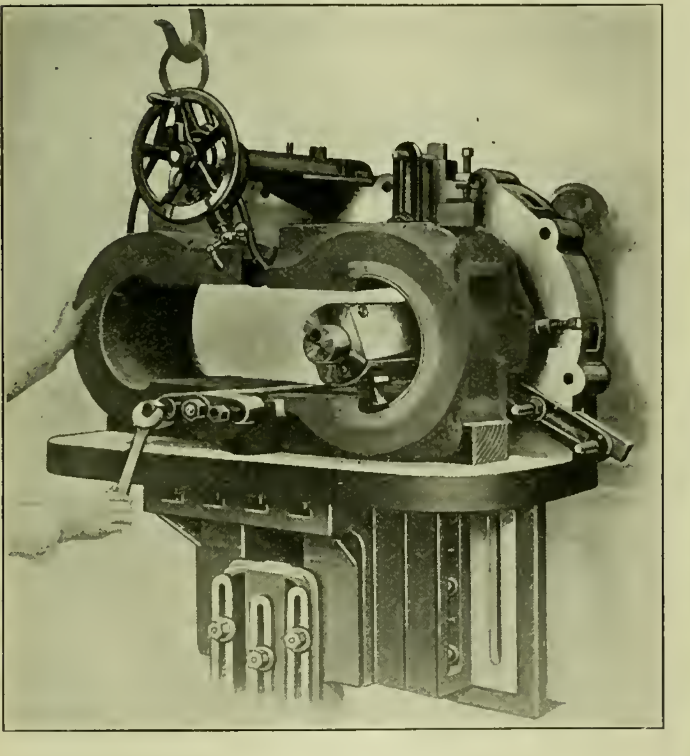


Fig. 1—Morton Double Chuck Driving Box Attachment

If the Morton draw-cut shaper was so highly specialized that it could be used only in machining driving boxes, its installation would be warranted only in those railroad shops having enough driving box work to keep the machine busy eight hours a day. The shaper can, however, be used on general machine work and special attachments have been designed for machining driving boxes all over and for finishing crown brasses, shoes and wedges, and main rod brasses. The addition of these attachments greatly increases the range of work for which the shaper is adapted and it can now be installed with profit in much smaller shops and roundhouses than heretofore. The flexibility of the machine and the ease of changing from one attachment to another make it a general utility tool which can be kept busy a large proportion of the time.

Double Driving Box Chuck

An improved double chuck for holding driving boxes is shown in Fig. 1. This chuck is made in the form of an angle plate which bolts securely to the knee of the machine and is alined at right angles to the ram. It is provided with a suitable opening for the ram and a special rotating head to pass through. Adjustable stops and binders secure the various sized driving boxes to the chuck.

A bracketed journal fastens to the top of the chuck and extends forward, bringing the operating hand wheel in a convenient position as shown. Power is transmitted through a universal shaft to the rotating arbor, which may be turned by hand in either direction. A limit stop screw is also provided in connection with the hand wheel so that the tool may be relieved on the return stroke when finishing the under-cut fit.

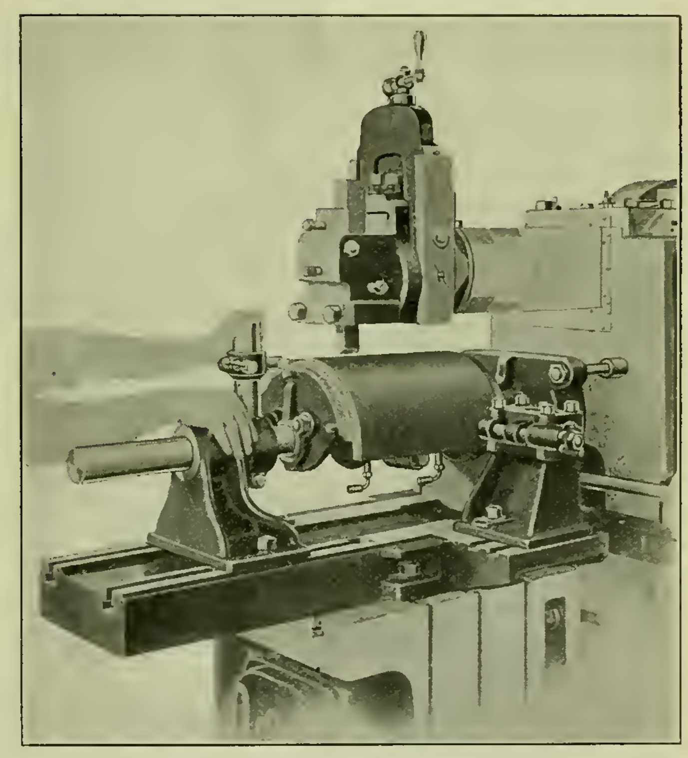


Fig. 2—Crown Brass Planing Attachment

In machining a driving box, the sides are first planed on the shaper without the use of the attachment. The attachment is then applied and one driving box centered by means of a scriber fitted to the micrometer projection of the rotating head. Micrometer setting of the tools is provided and the crown bearing can be machined accurately to size. The second box may be set up while planing the crown fit of the first box.

The under-cut fit is first roughed out while roughing the crown, a special forming tool being used for finishing. This tool can be set at a standard angle and rotated by hand feed so as to machine the box exactly to the line. The tool is relieved at each stroke and the stop advanced until the finish line is reached. After the brass is pressed in it may be planed to fit the journal if desired and a very true surface obtained by using a slightly crowned tool. For planing the shoe and wedge fit an extension bracket is bolted to the side of the knee and face of the saddle.

Planing the Crown Brass

For planing the outside of driving box crown brasses a special attachment is provided as shown in Fig. 2, a practical and efficient device for performing this machine operation. The base of the attachment is a rigid casting held in line with the ram by a tongue on the lower side. The arbor shown is rotated by a worm gear and turns freely in the head stock and tail stock bearings. The chuck for holding the brasses is keyed to the arbor and is held firmly against a shoulder by means of a clamp bolt. Set screws for lining and centering may be operated from the under side, and both front and rear heads are provided with set screws for holding brasses with rough ends. The two heads are drawn together by bolts so placed as to produce great pressure.

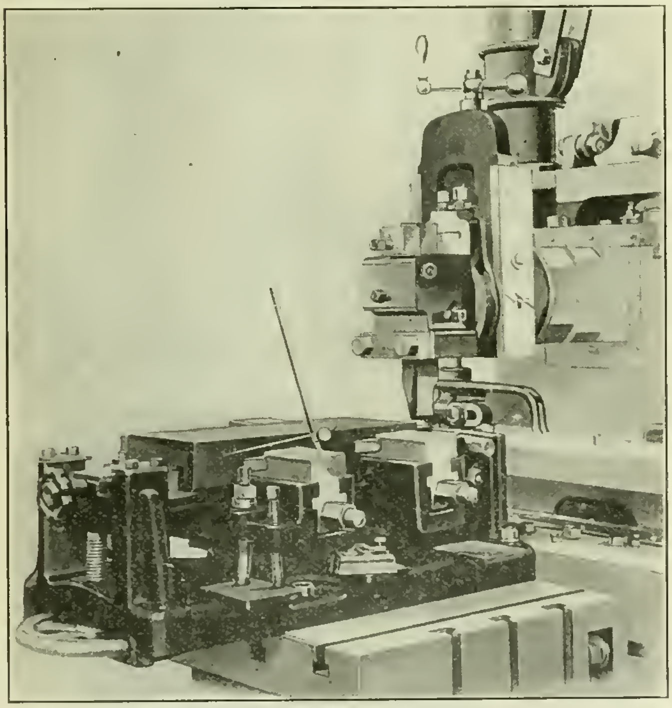


Fig. 3—Shoe and Wedge Planing Attachment

Chucks of different diameters are furnished for the various sized brasses and different lengths may be accommodated by means of the adjustable front head. The feed is obtained through a worm gear and shaft, connecting with the ordinary feed mechanism. Power feed in either direction is provided and the brass can be machined to the line scratched by the micrometer scriber. Adjustable transfer gages make it easy to caliper the driving box and determine the exact angle and position of the under cut. This angle is transferred to the crown brass by means of an outer gage.

Shoe and Wedge Attachment

An attachment for finishing the face bearings of shoes and wedges after they have been laid out and lined is illustrated in Fig. 3. Its construction is such as to make it readily adjustable to various angular requirements, all adjustments being made after the shoe or wedge is securely fastened in the attachment. One roughing and one finishing cut only is required. The principle of operation of the attachment will be evident from the illustration. The four adjustable jaws are expanded by a draw bar and a single screw. These jaws center the wedges of different size, bringing the inside (frame fit) parallel with the ram. Both sets of binders shown move freely in T-slots and are operated by single screws. The screw for elevating is operated by a hand wheel while the roll is obtained by means of two studs shown. When planing shoes the studs are loosened and the bar is elevated until it comes against a stop provided to hold the bar parallel with the shaper ram.

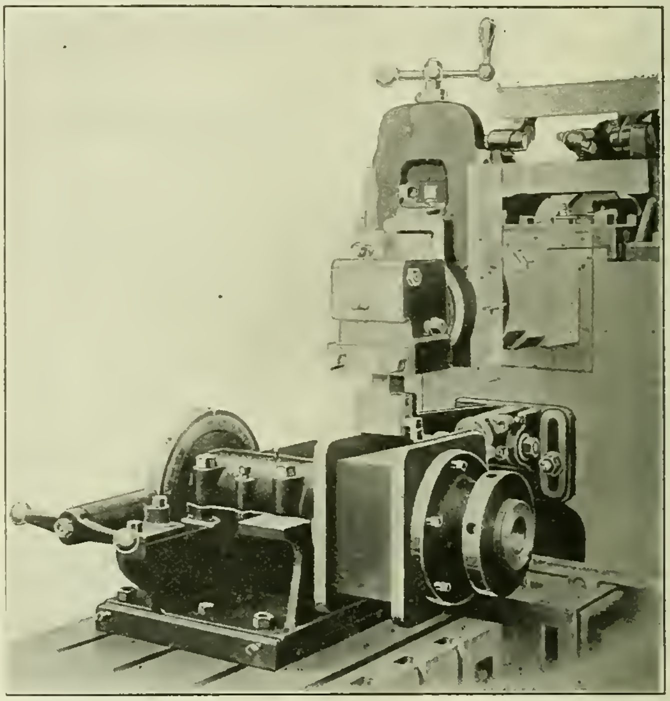


Fig. 4—Attachment for Machining Strap Fit in Rod Brasses

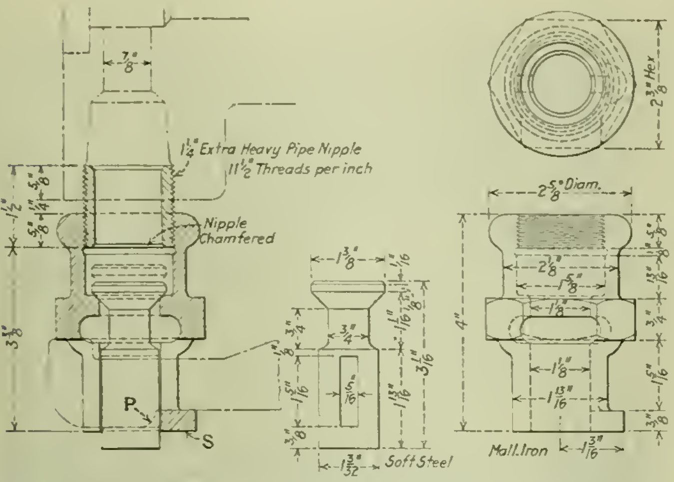
Machining Rod Brass Fits

Connecting rod brass fits in the straps can be accurately and quickly machined by means of the attachment shown in Fig. 4. The base plate of this device is provided with a tongue cast on the under side and fitted to a slot in the knee. The head is arranged to swivel on the base and is provided with set screws to secure perfect alinement, clamp bolts securely fastening the arbor in any desired position. Chucking is accomplished by fixed and sliding collars, pressure being applied to the sliding collar by a lever operated nut. Both collars are provided with cup pointed set screws which hold the brasses firmly and make it unnecessary to sweat the two halves together. An index plate is keyed to the rear end of the arbor and is provided with a plunger locking it securely at 90 deg. points. One side is graduated to 360 degrees so that any desired angle may be obtained.

The special tool holder furnished with this attachment is made of heavy machined steel slotted along two sides and one end to receive angular cutters. Two cutters are used at one time so constructed that they can be fastened in the holder independently of each other. With this form of tool holder, both sides of the strap fit may be machined at once to the exact size and parallel. An adjustable gage for setting the tool may be furnished consisting of a key-seated rod, one solid and one adjustable jaw. The gage is set by placing it directly on the strap and locking the adjustable jaw into position. The exact size is thus obtained for setting the tool.

Cylinder Cock Closes When Engine Drifts

A DEVICE for holding cylinder cock valves on their seats when an engine is drifting has been patented recently by L. P. Ligon, master mechanic, Norfolk & Western, Roanoke, Va., and found of great value in assisting lubrication and preventing dirt and other foreign matter from entering the cylinders with resultant unnecessary cutting and wearing. When cylinder cock bodies are of malleable iron and the valves of wrought iron, the seat cuts rapidly due to the valves being lifted by the vacuum in the cylinder when the engine is drifting. When brass or other soft metal is substituted for the wrought iron valve, the soft metal pounds out, necessitating frequent renewals.



View Showing Details and Cross Section of Closed Cylinder Cock

To prevent a cylinder cock valve from lifting when the engine is drifting a projection *P*, as shown in the illustration, has been made on the operating bar to engage the bottom of the slot in the valve when closed and hold it to seat. The projection enters for the full width of the valve when closed and passes out before the valve reaches the incline on the operating bar for opening it. A shelf *S* is made on the cylinder cock body to furnish additional support for the operating bar.

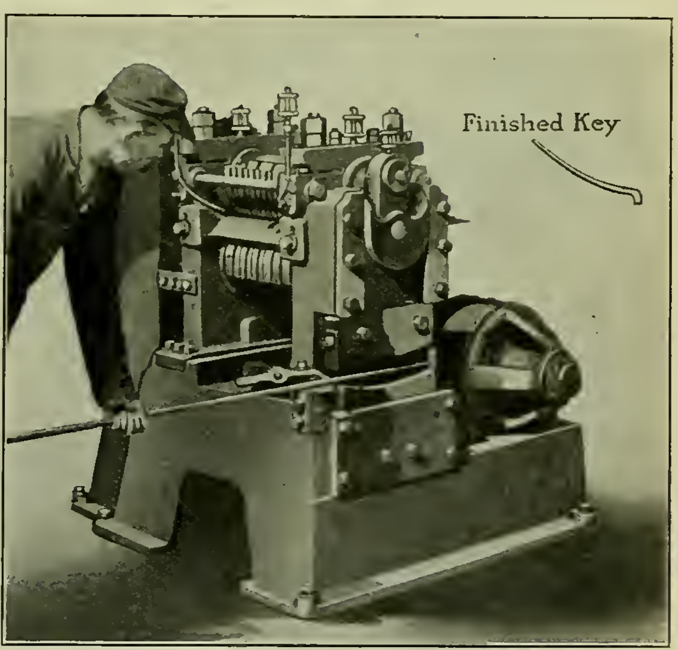
Engines equipped with cylinder cocks using this device have been in continuous service for more than a year without any renewals whatever being made, or any attention given to the cylinder cocks.

Brake Shoe Key Taper Rolling Machine

ALTHOUGH brake shoe keys have been produced by taper rolling for a number of years, many railroad men are not familiar with this process. Not only is the production of keys much greater but they are more uniform and of better quality than those obtained by drawing down under the hammer. The brake shoe key rolls, built by the Ajax Manufacturing Company, Cleveland, Ohio, have two horizontal roll-shafts to which are attached semi-cylindrical roll-dies, grooved to produce the taper of the key and operating between heavy housings. The upper roll-shaft is carried in slide housings and the pinions on the ends of the roll-shafts have exceptionally long teeth, so that the distance between roll-shaft centers can be varied. This adjustment regulates the thickness of the keys and also permits re-finishing the roll-dies, when they become worn, thus materially increasing their life. A side press operated from the upper roll-shaft shears off, bends and turns up the gib head on the brake shoe keys.

Either ½ in. by ⅞ in. rectangular or ¾ in. round stock of a convenient length to handle is used for making keys. Where cars are being wrecked, considerable scrap rod is available for this purpose. The stock is heated over a length of about two feet. The roll-shafts to which the dies are attached revolve continuously and during the half revolution when the roll-dies are not engaged, the operator ports the heated end between them against stock gages in the back. Front and rear guides hold the stock in position so that when the roll-dies engage, the stock enters into a groove and is rolled out toward the operator. He again ports it back into another groove making alternate flattening and edging passes.

Rectangular bars require only about four passes in the two flattening and one edging groove of the roll-dies; rounds require about six passes in the same three grooves, but the decrease in production because of the additional passes is more than compensated for when scrap rods are being thus reclaimed. The key is then sheared off the bar, bent and the gib head turned up in a single stroke of the side press. Two keys are completed at the same heat.



Ajax Brake Shoe Key Machine Performing the Final Operation in Making a Key

Because of the extreme simplicity of the operation, skilled or experienced operators are not required and production varies from 1,200 to 1,600 finished keys per eight-hour day, depending upon the activity of the operator and the kind of stock being used. Rolls of a similar type but larger size are used for tapering brake levers, crow bars, tong handles and other similar tapered forged pieces.

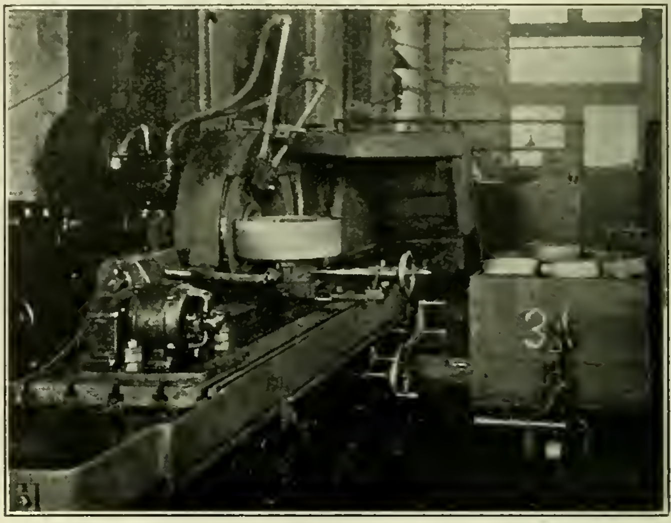
Improved Method of Crowning Pulleys

Crowning pulleys by grinding is not new but the method described in this article differs from others by employing a special fixture for use on a Diamond heavy duty face grinding machine. If a pulley is rotated about its axis inside a cylindrical wheel, a crown is obtained varying from zero to one equivalent to the segment of a circle the diameter of the inside of the wheel (28 in.). It is even possible to obtain a negative crowning or concavity by rotating the pulley against the outside of the cylinder wheel. Such concavities are not of importance as far as pulleys are concerned but might be of value in other classes of work. The pulleys are, of course, chucked and the edges finished before placing on the fixture. Production will vary somewhat depending upon the amount of stock to be removed and the regularity of the castings.

The peculiar shape of the wheel when trued for this work gives a very efficient shearing effect against the face of the wheel, resulting in high production. Working on 12 in. diameter pulleys, 4 in. wide face, the average production time of two to three minutes per pulley, floor to floor, is readily obtainable.

The pulley grinding fixture, illustrated, consists of two units, a plate with a vertical spindle and an electric motor with reduction gearing. The vertical spindle is of suitable diameter to fit the hole in the hub of the pulley and a pin, serving as a driving dog is inserted between the spokes. The pulley is rotated by power and the feed adjusted by hand. With a small change the fixture can readily be adapted to webbed pulleys.

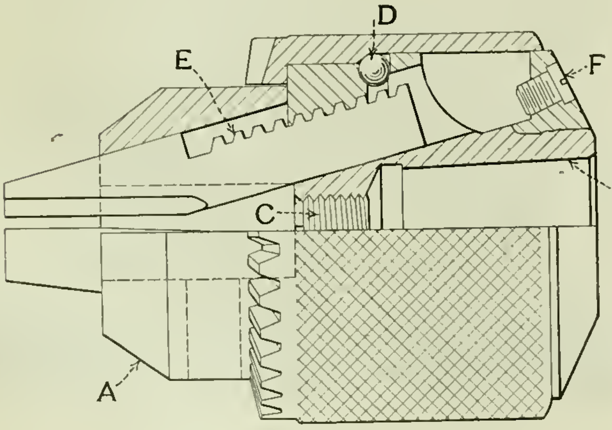
Pulley castings are usually very thin, often chilled, and frequently hard to machine. If machined on some types of lathes, low speeds and feeds are necessary and the percentage of breakage is high. Grinding offers the best solution of this as many other problems. The same principle can be successfully applied to the grinding of malleable iron brake shoes, rollers for conveyors, wheels for small trucks and similar work. This pulley grinding fixture is made by the Diamond Machine Company, Providence, R. I.



Diamond Pulley Grinding Attachment

Toothed Key and Sleeve Type Chuck

Accuracy, ease of operation and durability are features that have been kept in mind in the design of the new chuck made by the Jacobs Manufacturing Company, Hartford, Conn. This chuck is of the toothed key and sleeve type and is essentially the same as the chucks manufactured by this company for the past 18 years. The outward design has been changed slightly, however, to give better proportions as shown in the illustration.



Jacobs Toothed Key Type Chuck

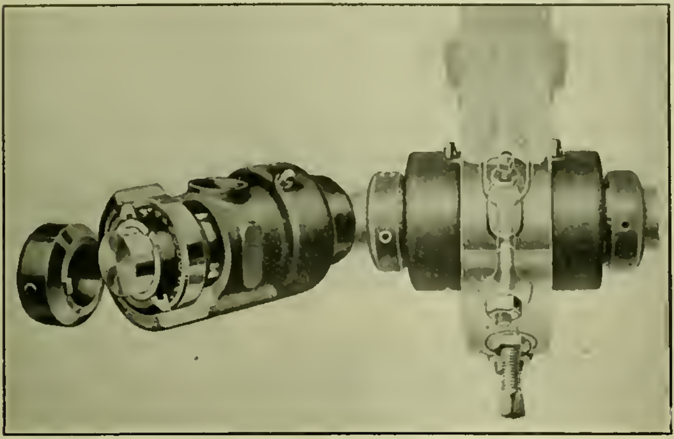
The body *A* is made of steel of a special analysis, deeply case hardened. Through a special process in this heat treating the taper hole *B* is left soft fitting it for use on a hardened and ground arbor. This taper hole is ground with great accuracy. A hole is drilled and tapped through the center of the body and fitted with a threaded plug *C* which may be easily removed with a screw driver if it is desired to insert rods or other material through the chuck. The taper hole on the chuck is of the same dimensions as those of previous designs. Each of the new chucks has been designed to meet the changed drilling methods of the last few years with relation to design, weight and capacity, all needless weight having been eliminated.

Ball bearings *D* inserted between the nut and the body reduce friction to a minimum making it possible to machine the thread *E* on the nut and the jaws with a coarser pitch than heretofore. Reduction of friction makes it possible to tighten the chuck with great ease, preventing undue wear on the keys, sleeves and other parts of the chuck at the same time giving greater gripping qualities.

An oil hole *F* inserted in the upper end of the chuck makes it possible to lubricate all of the working parts. One half the pressure on the key in tightening the chuck will produce the same results as in chucks of the previous design and the change in pitch of the thread on the jaws has resulted in reducing by one half the number of turns of the sleeve necessary to tighten or loosen the chuck.

Double Ball Bearing Hanger Boxes

Realizing the large amount of power lost in shops and factories where the shafting runs on plain bearings, the Fafnir Bearing Company, New Britain, Conn., has developed a double ball bearing hanger box designed to reduce friction and power loss to a minimum. Reference to the illustration shows that in this box the driving collar and wide inner ring, exclusive features of the Fafnir Bearing, make the usual adapter sleeves unnecessary and thus eliminate trouble in maintaining these parts.


Phantom and Assembled View of Fafnir Shaft Hanger Box

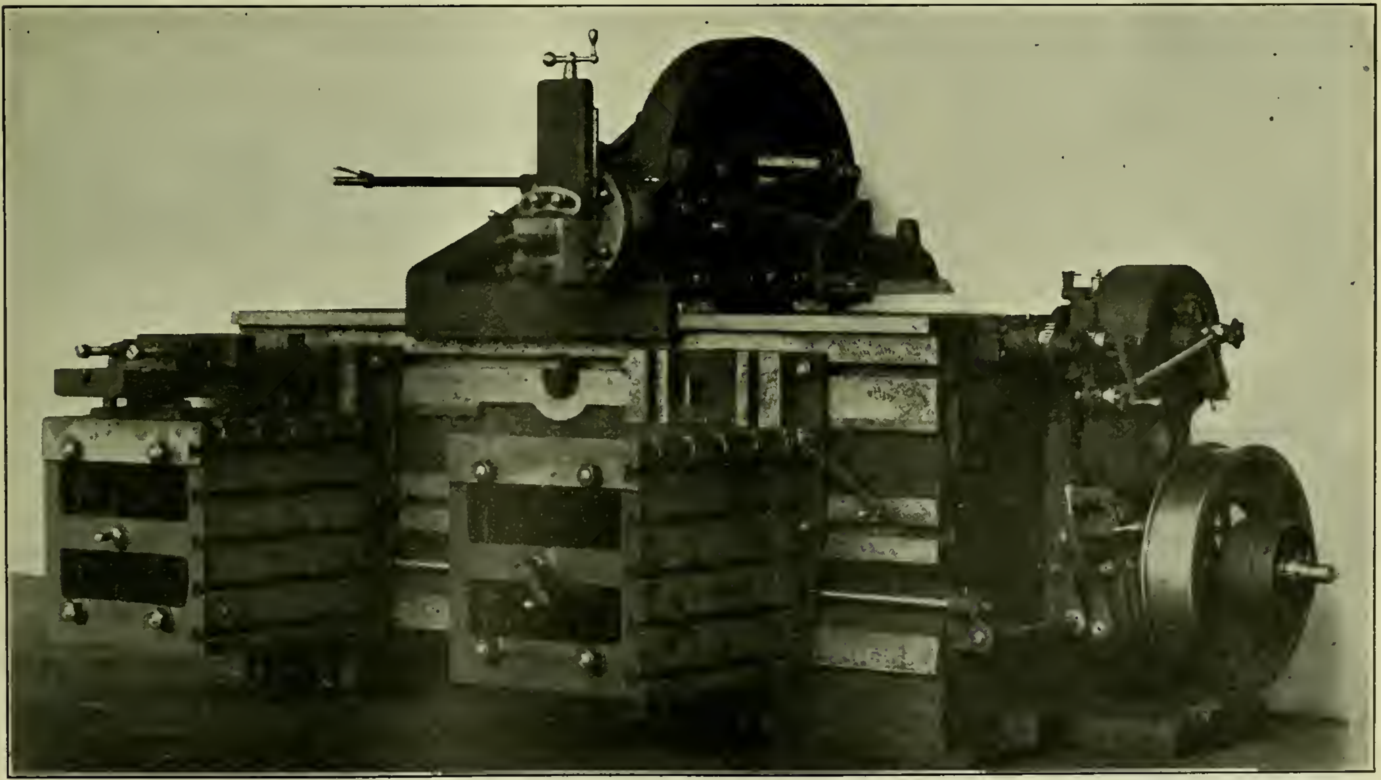
A collar is secured to the shaft at each end of the box by means of large set screws. The collar has lugs which mesh with corresponding slots cut in the inner ring of the ball bearing. Consequently the shaft, collar and inner ring revolve as a unit. Thus it will be appreciated that the collar drives the inner ring and transmits end thrust to the ball bearing. This construction makes it possible to ship each box completely assembled, and it can be put on the shaft as a unit, the driving collar being mounted on the shaft at each end of the box. There are no bolts or screws in the box to become loose and cause trouble; the wide inner rings of the ball bearings give the shaft ample support and provide a firm seat for the bearings; the box is supported in the middle and consequently any deflection of the shaft affects the box as a whole and does not interfere with the operation of the ball bearings.

Two ball bearings are installed in each box, being made of high-carbon, chrome alloy steel. The inner and outer rings and balls of these bearings are scientifically heat-treated and manufactured with extreme accuracy. Grease plugs are provided so that the bearings can be filled with grease when needed, which is not often. Felt packing rings prevent the lubricant from working out of the box. These double ball bearing boxes can be installed in any of the more common types of hangers.

Heavy Duty Traverse Head Shaper

The Putnam Machine Works of Manning, Maxwell & Moore, Inc., Fitchburg, Mass., has recently added to its line of modern machine tools, a 26 in. traverse head shaper. While this shaper is a general purpose machine, adaptable to use in any machine shop, it is essentially a railroad shop tool, and can be provided with the necessary equipment for efficiently machining the faces of driving boxes, shoes and wedges, and many other miscellaneous locomotive parts.

The principal features of this shaper, as shown in the illustration, are its generally heavy proportions, ability to transmit the power required for heavy cuts at high speeds


General View of the Putnam 26-In. Traverse Head Shaper

and to absorb the strains incident thereto. Every effort has been made to secure maximum convenience of control. The bed of the shaper is of rigid construction with all bearing surfaces hand scraped. The head has a liberal bearing surface on the bed and is gibbed. There are ample facilities for taking up wear and wipers keep the surfaces in contact free from dirt and grit. Power feed for the head along the bed is by means of a large screw carrying a ratchet on its extreme end for engaging, disengaging or reversing of feeds ranging from .01 in. to .17 in.

An open and shut nut in the head provides ready means for disengagement with the feed screw when it is desired to quickly traverse the head along the bed by means of a ratchet handle provided. The ram is of a strong box construction with ample bearing surfaces and is operated by the McCord quick return motion which produces a practically uniform cutting speed. Facilities are provided for quickly and conveniently setting the ram to any stroke or position desired. The tables are mounted on individual saddles and have vertical adjustment by means of screws mounted on ball bearings. Longitudinal adjustment along the bed is accomplished by ratchet handles which are attached to the saddles. The construction provides for the application of a circular attachment, if desired.

Drive by belt or constant speed motor is so arranged that speed changes are readily obtainable through a selective type gear box, all gears of which are made of chrome nickel steel, heat treated and hardened. They are lubricated by the splash system. A powerful friction clutch is used, operated from both ends of the machine by conveniently placed levers, and the act of disengaging the clutch applies a brake for quickly stopping the ram. Drive by variable speed motor is arranged with sufficient speed changes by gearing to give suitable speeds to the ram. Beds 14 ft. and longer are usually made into double machines, having the two heads independently driven by separate 7½ hp. motors.

Internal Micrometer of Unusual Design

A RADICAL departure from the usual construction of internal micrometers is embodied in a new instrument made by John Bath & Company, Inc., Worcester, Mass. In this measuring tool, four measuring jaws are provided having true cylindrical contact surfaces which make a broad line contact with the walls of the hole being measured. The measuring jaws are accurately lapped and nicely fitted without play in dovetailed slots. Perfect alinement and parallelism of the jaws is secured. The jaws are moved up the flat inclined supporting surfaces on the solid body of the micrometer by a micrometer screw of exceptional accuracy. The result is an internal micrometer which is as rigid as a solid plug. It is made in 32 sizes which will give continuous measurements by ten-thousandths from ⅞ in. to 3 in.

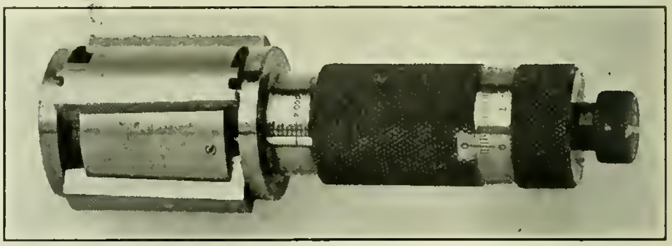
It is logical to measure cylindrical surfaces with a straight line contact, thus the use of the four parallel jaws with cylindrical contact surfaces, making a broad line contact with the internal cylindrical surface of a hole, gives uniformity in measuring machined, reamed or ground holes, and furthermore results in securing the limit of accuracy in measuring ring gages and the most accurate lapped holes. There is no indentation of the contacts in the surface being measured. The broad line contact secures at once a true measurement. When a measurement is taken and the jaws of the micrometer come in contact with the walls of the hole, they stop abruptly. Any number of persons will get the same result and the variations due to the sense of touch are, therefore, eliminated. A workman is enabled to ascertain quickly the exact size of the hole being machined. He knows the amount of metal removed per cut and all other conditions about the hole. This information gives him the assurance and ability to proceed rapidly in completing the work without risk of getting the hole over sized and adding to the spoilage loss.

A master reference ring gage, made by the John Bath Company, also departs from the usual form of construction. A deep wall section is provided with a series of concentric holes which have little effect in reducing the strength of the ring, but serve to reduce the weight materially and furthermore to provide for air circulation. This permits the ring to return more quickly to normal temperature after it has been heated or cooled. The construction of this master ring gage, therefore, results in securing maximum rigidity with minimum weight and the ability to expand and contract uniformly with changes of temperature.

Rules for Accurate Calipering

For accurate calipering, the surfaces of holes and of the micrometer should be washed with soap and water (preferably lukewarm water). This removes the grease, grit and all residue that may be left from gasoline, alcohol and other liquid and all sediment deposited from the atmosphere. After the contacting surfaces have been washed and thoroughly dried with a clean cloth or with new clean tissue paper, the micrometer is inserted in the hole and the jaws expanded until they are stopped by the walls of the hole, thus measuring the exact size of the lapped hole.

After having found the exact size of a hole, with the surfaces clean and dry, it is astonishing to note the changes which take place when oil or lubricant is present. Oil of any nature reduces the friction which caused the screeching and jerky movement, found when the micrometer was rotated in the ring, clean and dry. Oil makes the rotation of the micrometer smooth, and with oil present it is no longer possible to distinguish the large diameters from the small diameters; the high points from the low points. Furthermore, the micrometer can be expanded to be several ten-thousandths larger than the hole, and no appreciable difference in the force required to rotate the micrometer will be noticed. Oil entirely destroys "feel."


The 2-In. Bath Internal Micrometer

An excellent way to detect small irregularities such as depressions, high spots and slight conditions of bell mouth or taper in a lapped hole is to make use of a very thin film containing sediment or residue deposited from the air. If a lapped ring gage is first coated with castor oil, the excess oil being removed by vigorous rubbing with a clean cloth and the gage is allowed to stand for several hours, dust particles from the air will be deposited on the trace of oil left in the ring. A micrometer rotated in a ring treated in the foregoing manner develops a very thin brownish colored film by which it is possible to detect minute irregularities in holes. It is said that with the new Bath micrometer internal measurements can be made even more accurately and rapidly than external measurements with the usual form of micrometer.

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WE GUARANTEE, that of this issue 9,200 copies were printed; that of these 9,200 copies, 8,261 were mailed to regular paid subscribers, 8 were provided for counter and news company sales, 263 were mailed to advertisers, 32 were mailed to employees and correspondents and 628 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 49,400, an average of 9,880 copies a month.

The *Railway Mechanical Engineer* is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.)

Four locomotives were burned in a fire of undetermined origin which recently destroyed the roundhouse and machine shops of the Maine Central at Calais, Me.

W. O. Thompson, secretary of the Traveling Engineers' Association, has changed his headquarters from Buffalo, New York, to 1177 East Ninety-eighth street, Cleveland, Ohio.

The Transportation Club, Buffalo, N. Y., has appointed the following officers for the year 1921: Kendall B. Hassard, president; Judson M. Sells, first vice-president; Godfrey Morgan, second vice-president; Redmond J. Walsh, secretary and treasurer, and George C. Wilson, assistant secretary.

The United States Civil Service Commission has announced an open competitive examination for shop apprentices. Vacancies in the Bureau of Standards at $720 a year and positions requiring similar qualifications will be filled from this examination. Applications will be received by the commission at Washington, until August 1, 1921.

The Southern Pacific has recently completed a first aid station or emergency hospital at Bay Shore, South San Francisco shops, which makes the thirteenth emergency hospital unit on the company's Pacific system. The unit has an operating room, small ward, kitchen, waiting room and doctor's office, and the station is in charge of a trained nurse at all times.

Ninety miles in one hour and twenty minutes was the time made by a special train of two cars from Philadelphia to Jersey City on the afternoon of April 18, over the Philadelphia & Reading and the Central of New Jersey, a speed equal to 67.5 miles an hour. This train was run for J. L. Stokes, a banker, to enable him to connect with a train for Montreal, the Pennsylvania being blocked by a derailment and the Reading having no regular train for two hours. Mr. Stokes paid for the train $427.

Master Boiler Makers' Convention Deferred

The executive board of the Master Boiler Makers' Association has voted to defer the annual meeting which was scheduled to have been held at St. Louis, Mo., May 23 to 26.

Storekeepers' Annual Meeting

The Division of Purchases and Stores of the American Railway Association (Division VI) will hold a convention in Chicago, at the Hotel Blackstone, on Thursday, Friday and Saturday, June 9, 10 and 11.

General Secretary J. E. Fairbanks has issued a circular which says that the general committee of this Division, because of the financial stress and serious business conditions, has determined that it is necessary to defer the annual convention scheduled for Atlantic City. The Chicago meeting will be strictly for business. The sessions will convene at 10 a. m., city time. The general committee and standing committees will be in attendance. Members are requested to have such representatives of their supply departments attend as can conveniently do so. The meeting will consider Committee reports which are ready and will formulate a constructive plan for the future activities of the Division.

Machine Tool Builders Cancel Convention

The National Machine Tool Builders' Association announces that its spring convention, scheduled for May 19 and 20 at Atlantic City, N. J., is cancelled.

American Society for Testing Materials

The American Society for Testing Materials will hold its twenty-fourth annual meeting at the New Monterey Hotel, Asbury Park, N. J., on June 20 to 24, inclusive. Monday, June 20, will be devoted to committee meetings, and the first session of the annual meeting will be held on Tuesday morning, June 21.

Shop Construction

ATCHISON, TOPEKA & SANTA FE.—This road has awarded the contract for the construction of a blacksmith shop, 80 ft. by 307 ft., at San Bernardino, Cal., to Joseph E. Nelson & Sons, Chicago. The estimated cost is $150,000 and construction will commence at once.

Locomotives

The PEKIN-MUKDEN has ordered 19 locomotives from English builders.

The ATCHISON, TOPEKA & SANTA FE has ordered 10 Pacific, 15 Mikado, 15 Mountain and 10 Santa Fe type locomotives from the Baldwin Locomotive Works.

NATIONAL RAILWAYS OF MEXICO.—The General Equipment Company, New York, has sold to The Oliver American Trading Company, with New York City office at 61 Broadway, 65 rebuilt locomotives, including Mogul, 10-wheel and Consolidation type locomotives for use over the lines of the National Railways of Mexico in connection with the operation of the private freight trains of the Oliver company. This company, in addition to these 65 locomotives just purchased, also has leased 20 locomotives from American railroads, which, with the equipment they are now operating, gives it a total motive power of about 95 locomotives. This sale of the General Equipment Company has been made possible by virtue of certain arrangements between Senor Francisco Perez, Director-General of the National Railways of Mexico and

The Oliver American Trading Company, Inc., which plan provides a practical means of financing this equipment.

Freight Cars

The Delaware, Lackawanna & Western is having repairs made to 1,000 box cars at the Berwick shops of the American Car & Foundry Co. This is in addition to the 1,000 cars on which repairs were authorized to be made at the same plant last October.

The Atchison, Topeka & Santa Fe has ordered 1,000 50-ton gondolas from the American Car & Foundry Co.; and 300 50-ton gondola cars from Haskell & Barker Car Co., Inc.

The United Fruit Company, New York, has ordered 50 all steel ballast cars for the Pruxillo Railroad, Honduras, from the Magor Car Company.

The Beacon Oil Company, Boston, Mass., has ordered 20 tank cars, of 10,000 gal. capacity, from the General American Tank Car Corporation.

MEETINGS AND CONVENTIONS

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Business meeting June 15 and 16, Hotel Drake, Chicago, Ill.

Division V—Equipment Painting Division.—V. R. Hawthorne, Chicago.

American Railway Association, Division VI—Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio. Convention June 9, 10 and 11, Hotel Blackstone, Chicago, Ill.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamlin Ave., Chicago. Convention September 12-14, Hotel Sherman, Chicago, Ill.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago. Convention August 9, 10 and 11, Hotel Sherman, Chicago, Ill.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting June 20 to 24, inclusive, New Monterey Hotel, Asbury Park, N. J.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Spring meeting May 23 to 26, inclusive, Congress Hotel, Chicago, Ill.

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention September 19-24, Indianapolis, Ind.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Next meeting May 10. Annual meeting. Reports, smoker and entertainment.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Meeting second Monday in month, except June, July and August, New Morrison Hotel, Chicago, Ill.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 95 Liberty St., New York, N. Y. Next meeting May 12. Paper on the Manufacture of High Speed Steel will be presented by Felix Kremp, metallurgist, Atlas Crucible Steel Company, Dunkirk, N. Y.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Next meeting May 10. Paper on Experiences in Mexico will be presented by P. G. O'Hara, of the Galena Signal Oil Company. Entertainment by George J.. Breiel, Cincinnati Regalia Company.

Dixie Air Brake Club.—E. F. O'Connor, 10 West Grace St., Richmond, Va.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 715 Clarke Ave., Detroit, Mich. Next meeting August 16, 17 and 18, 1921, Hotel Sherman, Chicago, Ill.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill. Next annual meeting, May 24-26, 1921, Hotel Sherman, Chicago, Ill.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn. Convention, September 12, 13, 14 and 15, 1921, Hotel Sherman, Chicago, Ill.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York, N. Y.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting May 10. Paper on New England, Its Rivers, Mountains and Seashore, will be presented by E. S. Jones, official photographer, Boston & Maine, and will be illustrated by lantern slides.

New York Railroad Club.—H. D. Vought, 95 Liberty St., New York, N. Y.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Meeting second Thursday in month, alternately in San Francisco and Oakland, Cal.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Meetings fourth Thursday in month except June, July and August, Americus Club House, Pittsburgh, Pa.

St. Louis Railway Club.—B. W. Fraucnthal, Union Station, St. Louis, Mo. Next meeting May 6. Moving pictures and lecture on Thunder Bay to the Skeena River will be given by Capt. J. Milton State.

Traveling Engineers' Association.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Annual meeting May 16.

PERSONAL MENTION

GENERAL

M. B. McPartland has been appointed superintendent of motive power of the Denver & Salt Lake with headquarters at Denver, Colo., succeeding J. J. Connors, resigned on account of ill health.

O. P. Reese, superintendent of motive power of the Pennsylvania, Northwestern Region, with headquarters at Toledo, has been transferred to Chicago, succeeding O. C. Wright, assigned to other duties.

E. J. Summers, smoke inspector of the Chicago, Milwaukee & St. Paul, has been promoted to fuel supervisor, with jurisdiction over the system, and headquarters at Chicago.

John P. Kelly, for the past two years inspector of safety appliances in the Bureau of Safety, Interstate Commerce Commission, has been appointed senior railway mechanical engineer for that Bureau, with headquarters at Washington, D. C. Mr. Kelly was born in Great Barrington, Mass., on March 16, 1864, and received his early education in the public schools of that town; his engineering training was obtained in the engineering departments of the companies by whom he was employed. His first railroad service was on the Housatonic Railroad, now a part of the New Haven System, as water boy on passenger trains, in 1880. He was locomotive fireman in 1884, and locomotive engineman in 1887. He served as locomotive engineman on the New Haven and later on the New York Central; and in 1898 was appointed air brake instructor on the Central. In 1899 he was road foreman of engines on the Chicago & Alton; in 1901 he went to the New York Air Brake Company, where later he was appointed assistant mechanical engineer. In 1905 he resigned and went to the Westinghouse Air Brake Company but in 1910 resigned and devoted his time to the business of consulting air brake engineer, and to writing for the technical press. In 1912 he entered the employ of the New York Central Lines as consulting air brake engineer. Later he went into government employ as above stated.

J. P. Kelly

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

F. A. Gibbs has been appointed terminal road foreman of engines of the Atchison, Topeka & Santa Fe at Redondo Junction, Cal.

L. W. Gilbert has been appointed road foreman of engines of the Santa Fe at La Junta, Colo., succeeding C. A. Mays, assigned to other duties.

J. B. Merritt has been appointed road foreman of engines on the Second district of the New Mexico division of the Atchison, Topeka & Santa Fe, with headquarters at Raton, N. M., succeeding J. T. Stuvort, who has been transferred to the Third district.

Guy P. Mohler has been appointed terminal road foreman of engines of the Santa Fe at Needles, Cal., succeeding Earl Gilbert, transferred.

T. A. Roussin has been appointed master mechanic of the Missouri-Illinois which has been organized, with general headquarters at Bonne Terre, Mo., to take over the operation of the Illinois Southern. Mr. Roussin is located at Sparta, Ill.

CAR DEPARTMENT

Albert J. Krueger, whose appointment as master car builder of the New York, Chicago & St. Louis was announced in the March issue of the *Railway Mechanical Engineer*, was born on June 26, 1890, at Toledo, Ohio. He attended the Toledo High School and in 1908 entered the employ of the Lake Shore & Michigan Southern, later known as the New York Central. After serving successively as car repairer, car inspector, repair work inspector. piece work inspector, contract shop inspector, assistant general shop inspector and general shop inspector until December 1, 1916, Mr. Krueger entered the service of the Nickel Plate Road as general shop inspector and remained in this position until his recent appointment.

SHOP AND ENGINEHOUSE

Edward Bickerton has been appointed general foreman of the Canadian National Railways, with headquarters at Port Arthur, Ont.

Coincident with the consolidation of divisions on the Chicago, Rock Island & Pacific, appointments and transfers have been made as follows: G. M. Stone, master mechanic, with headquarters at Manley, Iowa, has been appointed general foreman, with the same headquarters. B. H. Smith, master mechanic, with headquarters at Fairbury, Neb., has been appointed general foreman, with the same headquarters. W. E. Danver, master mechanic, with headquarters at Amarillo, Tex., has been appointed road foreman of equipment, with the same headquarters. A. Hambleton, master mechanic, with headquarters at El Dorado, Ark., has been appointed general foreman, with headquarters at Shawnee, Okla.

H. M. Cooper has been appointed roundhouse foreman of the Santa Fe at Winslow, Ariz.

Charles Loud has been appointed assistant roundhouse foreman of the Atchison, Topeka & Santa Fe, at Las Vegas, N. M.

Minden McGee has been appointed foreman of the Santa Fe at Lamy, N. M., succeeding W. H. Sapp, transferred.

G. T. De Pue, mechanical superintendent of the Erie, with headquarters at Chicago, has been appointed shop superintendent at Galion, Ohio. The office of mechanical superintendent at Chicago has been abolished.

PURCHASING AND STOREKEEPING

J. F. Blasie has been appointed district storekeeper of the New York Central at Depew, N. Y., succeeding H. L. Grandy, transferred.

A. Herrera, formerly purchasing agent of the National Railways of Mexico, with headquarters at Mexico City, has been appointed to his former position. Mr. Herrera was born September 16, 1878, at Mexico City. He was educated at the Merchants' School of that city and entered railway service March 1, 1895, with the Mexican Central. After serving in several minor positions in the stores department he was appointed chief clerk of that department in 1901. In 1903 he was promoted to material accountant and served in that capacity until 1906 when he was appointed fuel agent. In 1909 when the Mexican Central was incorporated into the National Railways of Mexico, Mr. Herrera's duties were extended to include the maintenance of the fuel service of the entire system. In 1910 he was appointed purchasing agent. Mr. Herrera continued in this position until 1915 when, because of the revolution, he retired to private life. With the return of normal conditions he has again resumed the duties of his office.

A. Herrera

C. A. Dougherty, assistant district storekeeper of the New York Central at Elkhart, Ind., has been appointed storekeeper at Englewood, Ill., succeeding C. E. Shoup.

G. A. Goerner of the Chicago, Burlington & Quincy has been relieved of special duties assigned to him some time ago, and reappointed storekeeper at Clyde, Ill.

L. J. Green, formerly assistant general storekeeper of the New York Central at West Albany, N. Y., has been appointed storekeeper at Otis, N. Y., succeeding F. C. Vroman.

B. W. Griffeth, former assistant general storekeeper of the New York Central at Collinwood, Ohio, has been appointed district storekeeper, third district, with headquarters at Collinwood. Mr. Griffeth succeeds F. J. McMahon, who has been assigned other duties in the stores department at the same point.

R. S. Huffman, assistant general storekeeper of the New York Central at West Albany, N. Y., has been appointed district storekeeper, with headquarters at the same point, succeeding J. H. Seim, transferred.

W. H. King, Jr., assistant to the vice-president in charge of operation of the Seaboard Air Line, has been appointed general purchasing agent, and will succeed H. C. Pearce who has resigned.

A. L. Prentice has been appointed district storekeeper of the New York Central, with headquarters at Elkhart, Ind., succeeding C. F. Heidenrich, who has been transferred to Collinwood, Ohio, in the stores department.

J. B. Taylor has been appointed stores accountant of the Cleveland, Cincinnati, Chicago & St. Louis at Beech Grove, Ind., succeeding R. H. Kroger, assigned to other duties.

OBITUARY

F. V. McDonnell, master mechanic of the Northwestern Region of the Pennsylvania, with headquarters at Ft. Wayne, Ind., died on April 26.

Riley Laizure, formerly master mechanic of the New York, Chicago & St. Louis at Conneaut, Ohio, died February 24, 1921, at the age of 71 years, having been retired on a pension for one year. He is survived by a wife and three sons, one of whom, Lee R. Laizure, is now master mechanic for the Erie Railroad at Secaucus, N. J. Mr. Laizure was born in Steubenville, Ohio, and at the age of fifteen began work as a blacksmith apprentice at $9 per month, in a shop furnishing track tools for the Pennsylvania Railroad. After serving some time in the railroad shop at Denison, Ohio, he worked in the blacksmith shop of the Louisville & Nashville at Louisville, Ky., and left there during the panic of 1873 to enter the employ of a manufacturing company at Columbus, Ohio. Returning to railroad service, Mr. Laizure worked for the Pennsylvania Railroad and was one of the pioneers in the blacksmith shop department of the Erie Railroad. He worked for the Atlantic and Great Western at Galion, Ohio, when the gage was changed from broad to standard, and in later years served the Erie as blacksmith foreman at Susquehanna and Meadville. Returning to the industrial field in 1893, several years were spent directing blacksmith shop work for the American Locomotive Company at Richmond, Va., to be followed by 15 years as master blacksmith of the Nickel Plate at Conneaut, Ohio. Mr. Laizure was a mechanic of the old school, a well-known figure at the annual conventions of the International Railroad Master Blacksmiths' Association and highly esteemed by all those who knew him.

R. Laizure

SUPPLY TRADE NOTES

E. E. Goodwillie has been appointed sales agent in charge of the Cleveland office of the Bethlehem Steel Company, Bethlehem, Pa.

The G. M. Basford Company has removed its office from 30 Church street to the National City building, 17 East forty-second street, New York City.

The Rome Iron Mills, Inc., has removed its general offices from 30 Church street to the National City building, 17 East Forty-second street, New York City.

The Landis Tool Company, Waynesboro, Pa., has removed its New York sales office from 50 Church street to 51 Chambers street. M. G. Dunbar is the manager.

The Stone Franklin Company has removed its general offices from 30 Church street to the National City building, 17 East Forty-second street, New York City.

The Superheater Company removed its general offices on May 1 from 30 Church street to the National City building, 17 East Forty-second street, New York City.

The American Arch Company, Inc., has removed its general offices from 30 Church street to the National City building, 17 East Forty-second street, New York City.

The Franklin Railway Supply Company, Inc., has removed its general offices from 30 Church street to the National City building, 17 East Forty-second street, New York City.

Ralph T. Hatch has been appointed general manager of sales for the Reading Steel Castings Company, a subsidiary of the American Chain Company, with headquarters at Reading, Pa. Mr. Hatch entered railroad sales work with the B. F. Goodrich Rubber Company at Akron, Ohio, and was for several years railroad representative of this company. For the past 14 years he has been connected with the sales department of the National Malleable Castings Company, serving this company first as manager of Canadian sales with headquarters at Montreal, Can., and later going to the Chicago office of the company. At the time of his recent appointment he was serving as district manager of sales for the Northwestern territory, with headquarters at St. Paul, Minn., a position he had held for several years.


Ralph T. Hatch

The Universal Crane Company, Cleveland, Ohio, announces the removal of its plant from Cleveland, Ohio, to its new factory at Elyria, Ohio, which has recently been completed.

The Hutchins Car Roofing Company, Detroit, Mich., removed its New York City office on May 1 from 103 Park avenue to room 910 Canadian Pacific building, 342 Madison avenue.

The Lima Locomotive Works, Inc., has removed its executive and sales offices from 30 Church street to the National City building, 17 East Forty-second street, New York City.

The Railway Materials Company announces that on May 1 its general offices were moved from the Railway Exchange to suite 1900, Wrigley building, 400 North Michigan avenue, Chicago.

The Victor Tool Company, Inc., Waynesboro, Pa., has opened a branch office at 131 West Thirty-ninth street, New York, in charge of F. W. Curtis, manager, and Warren J. Boe, sales engineer.

The Gold Car Heating & Lighting Company on May 1 removed its offices from 17 Battery Place, New York City, and its warehouse to larger quarters at the Bush Terminal, 220 Thirty-sixth street, Brooklyn, N. Y.

The Standard Paint Company on April 1 changed its corporate title to the Rubberoid Company. There will be no change in the management or policy of the company, whose general offices will remain at 95 Madison avenue, New York.

Max Grant, whose appointment as manager of technical railway sales of the Glidden Company, Cleveland, Ohio, was announced in the March *Railway Mechanical Engineer*, was born in Berlin, Germany, in 1876. After serving for three years in the paint business in Germany he came to America in 1896, and went to the Devoe - Raynolds Company, serving first at Chicago and then at New York. About five years later he was appointed superintendent and later became manager of the Canton Paint & Varnish Company, Canton, Ohio. In 1910, he was appointed manager of the railroad paint department of the Wrinkle Paint Manufacturing Company, Columbus, Ohio, and since 1915, was manager of the railway paint department of the Tropical Paint & Oil Company, Cleveland, until his recent appointment as manager of technical railway sales of the Glidden Company with headquarters at Cleveland.


M. Grant

The W. T. Dunn Co., 10 High street, Boston, Mass., has been appointed New England sales agent for B. M. Jones & Co., Inc., 192 Chambers street, New York, importer of Mushet and Titantic tool steels, and Taylor's best Yorkshire iron.

Charles M. Chamberlin, secretary and director of A. M. Castle & Co., Chicago, for the past 20 years, retired from all active business associations on April 1. Fred C. Conners has been elected a director and secretary to succeed Mr. Chamberlin.

J. J. Connors, until recently superintendent of motive power of the Denver & Salt Lake, has formed a connection with the Lowe Brothers Company, Dayton, Ohio, as railway representative, with office at 1243 Monadnock building, Chicago, Ill.

The E. Horton & Son Company, Windsor Locks, Conn., has bought the chuck business of the American Company, Hartford, Conn. The American Company has specialized in the manufacture of a 3-jaw geared drill chuck known as the Ellison chuck.

The Modern Tool Company announces arrangements whereby the E. L. Essley Machinery Company, 551 Washington boulevard, Chicago, becomes exclusive selling agents in the Chicago territory for Modern plain and universal grinding machines.

The offices of the Pocket List of Railroad Officials and the official Railway Equipment Register, published by the Railway Equipment and Publication Company, have been removed from 75 Church street to larger quarters at 424 West Thirty-third street, New York.

Allan A. Ryan has resigned as a director of the Chicago Pneumatic Tool Company, New York, and also as a director of the Vanadium Corporation of America. Mr. Ryan has been succeeded on the board of the latter company by T. M. Schumacher, president of the El Paso & Southwestern System.

The Pressed Steel Car Company, Pittsburgh, Pa., removed its New York office on May 1, from 24 Broad street, to the Seaboard National Bank Building, corner of Broad and Beaver streets. The stockholders of this company at a recent meeting ratified an increase of capitalization from $25,000,000 to $50,000,000.

F. W. McIntyre has been appointed general sales manager of the Reed-Prentice Company and the Whitcomb-Blaisdell Machine Tool Company, Worcester, Mass., also the Becker Milling Machine Company, Hyde Park, Boston, succeeding J. P. Ilsley, who has resigned to go with the Taylor Steel Construction Company, New York.


R. A. Bole

Robert Alexander Bole, vice-president, director and district sales manager of Manning, Maxwell & Moore, Inc., New York, died on April 2, at the age of 62, in the Schenley Hotel, Pittsburgh, where he made his home. Mr. Bole was widely known in the iron, steel and railroad circles. He was born in Old Allegheny City, and received his education in the Pittsburgh schools. In early life he became identified with the Westinghouse Machine Company and rose from the ranks to secretary of that company. Following his long service with the Westinghouse interests, he became identified with the manufacturing company of Niles-Bement-Pond Company, New York, and resigned from that company to become associated with Manning, Maxwell & Moore, Inc. At the time of his death, he had been identified with the latter company for a period of 26 years.

Robert B. M. Wilson, sales engineer in the Indiana district for the Conveyors Corporation of America, Chicago, has been appointed sales engineer of the Chicago district, and E. W. Wolfe, who has been for several years with the company in a sales capacity, becomes an assistant to Mr. Wilson, with headquarters in the corporation's main office at 326 West Madison street.

Frank N. Grigg has been appointed southeastern sales manager of the Morton Manufacturing Company, with headquarters at 630 Louisiana avenue, Washington, D. C. Mr. Grigg will handle the sale of the entire "Acme Line" of railway appliances. C. H. Kadie, formerly master mechanic on the Southern Railway, is now in the sales department of this company and will assist Mr. Grigg.

William T. Lane, district manager of the Pacific Coast territory of the Franklin Railway Supply Company, Inc., New York, has been transferred from San Francisco to Cleveland, Ohio, as district manager of the Cleveland territory, and James McLaughlin, assistant to the vice-president at Chicago, has been transferred to San Francisco as district manager of the Pacific Coast territory to succeed Mr. Lane.

W. H. Noble has been appointed district manager at Chicago of the Texas Company, Houston, Texas, succeeding John J. Flynn, deceased. Offices have been opened at St. Louis, Mo., 1689 Arcade building, with F. E. Sheehan, representative in charge; Los Angeles, Cal., 1206 Merchants National Bank building, with J. B. Flynn, representative in charge, and at Oklahoma City, Okla., with L. R. Dallam, representative in charge.

The Cincinnati Grinder Company, Cincinnati, Ohio, has recently placed the sale of its line of grinding machines on an exclusive basis with the Marshall & Huschart Machinery Company in the Chicago district; Motch & Merryweather Machinery Company in the Cleveland, Cincinnati, Pittsburgh and Detroit district; Henry Prentiss & Co. in the New York and New England district, and will also maintain its own grinding specialists in the respective territories.

The W. R. Hickman Lumber Company has been organized in Cleveland, Ohio, with W. R. Hickman, for the past five and a half years sales manager for the Nicola Stone & Myers Company, as president. The company will specialize in railroad and industrial lumber, handling yellow pine, West Coast stock, ties and hardwood car material. The general offices of the company are at 1264 Hanna building, Cleveland, Ohio, with representatives in Hattiesburg, Miss., and Seattle, Wash.

The Lilly Varnish Company, Indianapolis, Ind., has been sold to an organization consisting of C. M. Malott, president; C. F. Brigham, vice-president and general manager; C. F. Hackathorn, vice-president in charge of manufacture and purchases, and W. I. Longsworth, secretary and sales manager. Mr. Malott is also president of the Indianapolis Paint & Color Company. William Lilly, who has managed the Lilly Varnish Company for a long time, will remain with the new organization as treasurer.

The Fosdick Machine Tool Company, Cincinnati, Ohio, have taken over all patents, drawings, patterns, jigs and fixtures covering the line of Pierle quick change high speed ball bearing sensitive drill presses, from the R. K. Le Blond Machine Tool Company. This acquisition by the Fosdick Machine Tool Company will give them a complete line of drilling machinery, consisting of heavy duty radial drills, heavy duty upright and gang drills, and high speed sensitive single and multiple spindle drills.

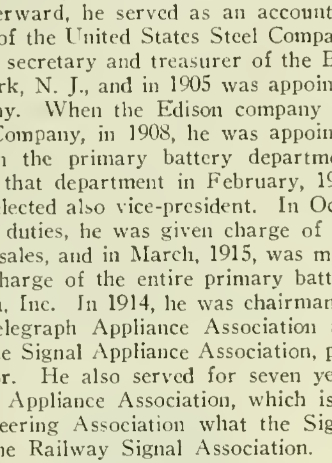

H. K. Porter

H. Kirke Porter, president of the H. K. Porter Company, Pittsburgh, Pa., died on April 10, at his home in Washington, D. C. He was born on November 24, 1840, at Concord, N. H., and studied at Newton Theological Institute and at Rochester Theological Seminary. He enlisted with the 45th Massachusetts Volunteers in 1862, and was mustered out of service in July, 1863. Mr. Porter served in the United States Christian Commission during the winter of 1864, and began his business life in 1866, as a member of the firm of Smith & Porter, manufacturing exclusively light locomotives. In 1871 the firm became Porter, Bell & Company. In 1879 it was changed to H. K. Porter & Co., and in 1899 was incorporated under the name of the H. K. Porter Company. During the past 20 years, the firm has been engaged in manufacturing heavy as well as light locomotives. This concern was the first to make compressed air locomotives for mine and general industrial use. Mr. Porter was a member of the 58th Congress from 1903 to 1905.

The Air Reduction Sales Company, Inc., manufacturers of Airco oxygen, acetylene and welding and cutting apparatus, moved its executive offices on May 1, from 120 Broadway to 342 Madison avenue, New York City. The New York district office at 160 Fifth avenue, New York, is now located at the Airco factory, 191 Pacific avenue, Jersey City, N. J. The company has secured control of the National Carbide Corporation of Virginia, with a new plant at Ivanhoe, Va., and will direct the policy and control the operation and sales of the Carbide Corporation.

The Elliott Company, Jeannette, Pa., announces the following changes in the company's sales organization: W. A. Darrow, who has been district sales manager of the Philadelphia office for the past ten or fifteen years, has been appointed special representative, with headquarters at Philadelphia. T. F. Crawford, St. Louis district sales manager, has been transferred to the Philadelphia office in the same capacity. C. L. Draper, of the Kansas City office, has been made district sales manager of the St. Louis office, and M. C. Sickels, of the Cleveland office, has been made Cleveland district sales manager, succeeding D. S. Tucker. All of the above will have charge of the sale of the products of the Lagonda Manufacturing Company, Springfield, Ohio, and the Liberty Manufacturing Company, Pittsburgh, in addition to those of the Elliott Company.

E. E. Hudson, vice-president and general manager of the Waterbury Battery Company, Waterbury, Conn., has been elected president of the company to succeed Charles B. Schoenmehl, deceased, and Francis T. Reeves has been elected treasurer. Mr. Hudson for the past 22 years, with the exception of a little over a year's time, has been in the sales and managerial departments of concerns manufacturing primary batteries and has been identified with the installation of the primary battery. In July, 1898, he served as chief clerk in the primary battery sales department of the Edison Manufacturing Company, remaining in that position until June, 1902. Shortly afterward, he served as an accountant in the controller's department of the United States Steel Company. In December, 1903, he became secretary and treasurer of the Battery Supplies Company, Newark, N. J., and in 1905 was appointed sales manager of that company. When the Edison company absorbed the Battery Supplies Company, in 1908, he was appointed assistant manager of sales in the primary battery department. He became sales manager of that department in February, 1909, and in September, 1913, was elected also vice-president. In October, 1914, in addition to these duties, he was given charge of the manufacturing, as well as the sales, and in March, 1915, was made division manager in general charge of the entire primary battery business of Thomas A. Edison, Inc. In 1914, he was chairman of the Railway Telephone & Telegraph Appliance Association and in 1916, he was chairman of the Signal Appliance Association, previously having been a director. He also served for seven years as a director of the National Appliance Association, which is to the American Railway Engineering Association what the Signal Appliance Association is to the Railway Signal Association. On January 1, 1917, he was elected vice-president and general manager of the Waterbury Battery Company and now becomes president of the same company.



R. G. Coburn

Ralph G. Coburn, president of the Stone Franklin Company, New York, has been elected also a vice-president of the Elvin Mechanical Stoker Company with headquarters at 50 Church street, New York, and E. W. Englebright, who became associated with the Elvin Mechanical Stoker Company in December, 1920, has also been elected a vice-president of that company. Mr. Coburn was born in Boston in 1882 and was graduated from Harvard in 1904. He then served, until 1909, with the American Glue Company in charge of its western territory, with headquarters at Des Moines, Iowa, and Chicago. On May 1, 1909, he opened the Chicago office of the Franklin Railway Supply Company as resident sales manager and in June, 1911, was appointed assistant to the vice-president in charge of eastern-southern territory, with headquarters at New York. In December, 1913, he was appointed eastern sales manager of the same company. In May, 1919, the Stone Franklin Company, New York, was organized to market the Stone Franklin car lighting system in the United States and Canada and Mr. Coburn was elected president of the new company, which position he retains in addition to his new duties as vice-president of the Elvin Mechanical Stoker Company.

TRADE PUBLICATIONS

Grinding and Polishing Machinery.—The Webster & Perks Co., Springfield, Ohio, has issued a catalogue made up of various bulletins which describe the different types of ball bearing and plain grinding and polishing machinery which they manufacture. An illustration of each machine and specifications are included.

Foundry Practice.—A very complete handbook on foundry practice has been issued recently by the Farrell-Cheek Steel Foundry Company, Sandusky, Ohio. The book, which is printed in four colors, not only describes, but illustrates profusely each operation required in the making of a casting, the same casting or pattern being used throughout.

Reamers at Work.—Under this title the Gisholt Machine Company, Madison, Wis., has issued an eight-page, illustrated booklet describing a solid adjustable Gisholt Reamer. This reamer is made in three body types: namely, shell reamer, straight shank machine reamer, and paper shank machine reamer. A size and price list is included in the catalogue.

Horizontal Return Tubular Boilers.—The Bigelow Company, New Haven, Conn., has reprinted in a separate book matter relating to their return tubular boilers and appearing in the company's regular catalogue. This includes a general description of this type of boiler, detailed instructions for setting, illustrations of boilers and furnaces and comprehensive tables of data.

Flange Oiler.—Catalogue No. 4 issued by the Hoofer Manufacturing Company, Chicago, contains 12, 5 in. by 8 in. pages devoted to a description of the Hoofer pneumatic flange oiler. A complete description of the construction and operation of this device is accompanied by suitable illustrations. A detailed illustration of the application of the lubricator, piping, control valve and oil distributors also is included.

Railroad Shop Grinding.—Under the title Grinding in Railroad Shops the Norton Company, Worcester, Mass., has recently issued a small 28-page booklet on this subject. The material is very interestingly arranged and accompanied by numerous illustrations. Among the subjects covered may be mentioned the grinding of piston rods, pins, car axles and wheels, valve parts, links, guide bars and miscellaneous shop tools.

Pointing, Thread-Cutting and Tapping Machinery.—The Webster & Perks Co., Springfield, Ohio, has issued a catalogue made up of various bulletins which describe and illustrate the different types of pointing, thread-cutting and special tapping machinery which they manufacture. The bulletins are grouped so that a separate section is devoted to a general description of each type of machine. Adjustable spring dies, and clamp die collars, optional holding devices, special holding devices and an improved geared rotary oil pump are also featured.

Advantages of Superheated Steam.—What Every Executive Should Know About Superheated Steam is the subject of Bulletin No. T-7 recently issued by the Superheater Company, New York. The bulletin discusses superheaters for stationary power plants and is designed to appeal to the executives and, therefore, has been made non-technical. After a brief explanation of superheated steam and the methods of producing it, the economies effected by its use are discussed, the concluding section dealing with the application of superheat to existing power plants.

Furnaces and Blowers.—A thorough discussion of various types of furnaces from the practical standpoint is one of the principal features of Catalogue No. 80 recently issued by the Chicago Flexible Shaft Company, Chicago. Particular attention is given to the requirements of furnaces for porcelain enameling, but much of the information is equally applicable to the types used in railroad shops. The general requirements of furnaces are taken up and muffle and semi-muffle types are discussed. This is followed by selections dealing with fuels and refractories. Several types of furnaces are illustrated and described together with the Stewart positive pressure blowers. The melting points of chemical elements and tables for the conversion of temperatures of the Fahrenheit and Centigrade scales are included.

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Volume 95 June, 1921 No. 6

CONTENTS

EDITORIALS:

The Present Situation in the Mechanical Dept. . 334
Some Prospect of Improvement 334
Starting Over With a Clean Slate 334
More Repair Work Must Be Done 334
Bad Order Cars, 14.2 Per Cent 335
The Locomotive Situation 335
Shops Are the Neck of the Bottle 335
Engine Terminal Development 335
Making Foremen Local Managers 336

COMMUNICATIONS:

A Decision That May Be Misconstrued 336
New Books 336

GENERAL:

The Roundhouse Up to Date 337
Frame Bolt Puller 340
Revivifying the Railroad Shop 341
Economic Advantages of Large Freight Locomotives 346
Sifter for Renovating Old Sponging Waste 348
Scheduling Car Repairs Increases Shop Output . 349
Reclamation of a Badly Distorted Tender Frame . 352
The Problem of Machine Tool Selection 353
Improving a Shop by a Limited Expenditure . . . 355
Fractures in Boiler Tubes 356
Vitalizing Locomotives to Improve Operation . . 357
Air Brake Association Holds Executive Meeting . 362
A Visit to a Railroad Shop 365
New Norfolk & Western 100-Ton Coal Cars 367
A T-Square Attachment 370
Widening the Outlook of the Local Car Foreman 371
Welding Cylinders with Tobin Bronze 374
Modifications in Rules Proposed by C. I. C. I. & C. F. A. 375
Labor Board Announces General Wage Reduction 379
Device for Spreading Locomotive Frames 380

NEW DEVICES:

High Production Double Axle Lathe 382
New Model Scrap Reclaiming Rolls 383
Hollow Spindle Thread and Form Miller 383
Geared Head Lathe Made in Three Sizes 384
Fifty-Four Inch Tire Turning Lathe 385
Ball Bearing Heavy Duty Radial Drill 386
Wire Brush for Cleaning Metal Surfaces 387
Heavy Planer Type Milling Machine 388
Rugged Construction Marks New Planer 388
Improved Tools for Machinists and Toolmakers . 389
Rotary Piston Pneumatic Grinder 390
Heavy Duty Reversing Motor Face Grinder 390
Universal Flue Welding Machine 391
Electric Truck Equipped with Carrying Ram . . . 391
Portable Device for Sand Blasting 392
Motor Drive Applied to Crank Planer 392
Milling Machine with Rectangular Overarm 393
Double Annual Ball Bearing Floor Grinder 394
Single and Double Spindle Threading Machines . 394
Twenty-One Inch Heavy Duty Upright Drill . . 395
Cold Metal Saw for Heavy Duty 396
Roller Bearing Featured by Staggered Rolls 396
Drilling Machine With Nut Facing Fixture 397
Cone or Single Pulley Driven Shaper 398
Self-Opening and Adjustable Die Heads 398
Double Spindle Centering Machine 399
Hack Saw Blade With Fine and Coarse Teeth . . 399
Semi-Automatic Twist Drill Grinder 400
Convenient and Durable Bench Vises 400
Improved Electric Self-Loading Truck 401
Sectional Wheel Chuck for Face Grinder 401
Three-Quarter Inch Double Spindle Threader . . 402
Overhead Swing Cut-Off Saw Table 402
Pressure Seated Valve Reduces Air Losses 403
Lathe Lead Screw Variator Device 403
Air Hose Coupling of Simple Design 404
Portable Safety Vacuum Torch 404
Dearborn Non-Volatile Liquid Cleaner 404
Spot Welding Machine of New Design 405
A New Idea in Chain Making 405
Metal Booth for Timekeepers and Foremen 406
Self-Oiling All Geared Gang Drill 406
Oscillating Surface Grinding Machine 407
Know Your Cutting Feeds and Speeds 407
Ratchet Die Stock in Close Quarters 408
Cone Pulley Gap Bed Lathe 408
Electric Grinder and Buffing Machine 408

GENERAL NEWS:

Notes 409
Meetings and Conventions 410
Personal Mention 411
Supply Trade Notes 412
Trade Publications 414

EDITORIALS

The Present Situation in the Mechanical Department

THE railroad situation at the present time is a serious one for all concerned. Complaint is heard from the public that freight and passenger rates are too high. Yet despite these high rates the roads are not earning anywhere near the 6 per cent that was set up as a fair return by the Transportation Act. Normally, operating expenses are about 70 per cent of the gross revenue, but during the first three months of 1921 the larger roads on an average spent 92 cents out of every dollar for operating expenses. After paying taxes and rentals, less than two cents out of the dollar were left to pay interest on stocks and bonds. Such a condition could not be allowed to continue very long or a large share of the roads would have been bankrupt. The only alternative was to reduce expenses by stopping all but absolutely necessary work. Maintenance has been curtailed, many shops have been shut down entirely and other drastic economies have been put in force, but even so, many roads are still operating at a loss.

In times of business depression, like the present, it would be desirable for the roads to do more than the usual amount of work, instead of less. There is a great deal of equipment in need of repair and new locomotives and cars should be ordered in large numbers. But so long as the roads are unable to earn a fair return upon the capital invested in them, no one wants to lend them money and they cannot buy. So the first thing needed to get the railroads on their feet and to put railroad men back to work is an improvement in the earning power.

Some Prospect of Improvement

THERE is reason to believe that the roads will soon be in better condition to earn a fair rate of return. The freight traffic has increased slightly in recent weeks and any increase in revenue will permit an increase in the net earnings. However, a heavy traffic alone would not suffice, for during the last four months of 1920, with the new rates in effect, the roads handled the largest traffic ever known at that season of the year, yet their earnings were at the rate of only 3⅓ per cent annually.

It is doubtful whether the volume of business existing in 1920 will soon be restored. At any rate, it is evident that, regardless of the increase in traffic, there must be a considerable reduction in expenses wherever it can be effected. W. Jett Lauck has asserted that a billion dollars a year could be saved by more efficient management without any reduction in wages. This would be highly desirable if it were possible, but when the statement is analyzed, its absurdity becomes apparent. After the Labor Board had granted the wage increase last July and while the railroads were still handling a heavy traffic, their total operating expenses were at the rate of about $6,000,000,000 a year and of this amount almost $4,000,000,000 was paid out in wages. If a billion dollars was to be saved without reducing the payroll, all other expenses would need to be reduced almost 50 per cent. About four-fifths of this other $2,000,000,000 is spent for fuel and for materials and supplies. Railroads are universally known as being very close buyers, and there is no evidence that large sums can be saved in expenditures for material. There has been some reduction in prices during recent months and of course the roads will benefit by them, but not to a very great degree.

In the last analysis, some reduction in wages is inevitable. Fortunately, it is not only necessary; it is also justifiable. The report of the National Industrial Conference Board for May 1 showed that the cost of living was 65.7 per cent higher than in July, 1914, while the peak in 1920 was 104.5 per cent above the pre-war level. The Labor Board has recognized this situation and has announced that wages will be reduced. While such reductions are always unwelcome, the workers have little cause for complaint. There may be fewer dollars in the pay envelope, but they will buy as much in food, clothing and other items as did the higher wage six or eight months ago.

The labor unions in presenting their case before the Labor Board made sensational charges that have received wide publicity. The railroads' side of the case has not been as widely circulated and probably many of the employees have seen little of the evidence except that presented by their organizations and published in the unions' papers. It is important that railroad officers should know both sides and be able to counteract the propaganda of the labor organizations which may tend to cause dissatisfaction over the new wage scale. The rank and file of shop employees are intelligent, reasonable men and there is no reason to question that they will accept the decision of the board in the proper spirit if they are shown that it is necessary and also that it is fair.

Starting Over With a Clean Slate

THE abolition of the national agreements and the reduction of wages make the labor situation at this time particularly important. The first of July will open a new era in the relations between the railways and their employees. The rules drawn up and the precedents established in the next few months will probably determine the policies that must be followed for many years to come. Every railroad officer should be careful to get the right start under the new conditions. There has been too much hiding behind rules in the past; the time has come to see that every man gives a fair day's work for his day's pay. The foreman must deal with the men in a reasonable manner, but he must have the authority to enforce discipline which is necessary for efficient operation. Questions of minor importance must be settled locally and without losing the production of several men over every real or fancied grievance. Both sides should live up to a reasonable interpretation of the decisions made by the Labor Board. What is needed is absolute fairness and more regard for the spirit and less for the letter of the agreement.

More Repair Work Must Be Done

THE new working rules and new wage rates will probably bring about a gradual improvement in the railroad situation, although considerable optimism is required to foresee good times in the immediate future. The railroad situation is dependent on general business conditions and little improvement is expected before August. Eventually, of course, the traffic will increase to its normal volume and then the difficult problem will be to take care of it. Equipment has been going from bad to worse and the shops must soon resume operation on a big scale to prevent the equipment literally falling to pieces. Already the freight car situation is becoming very serious and a car shortage in the near future is not only probable, but inevitable if the present tendency continues.

Bad Order Cars, 14.2 Per Cent

A FEW weeks ago, on April 8, a new record for the number of freight cars standing idle was established when the car surplus amounted to 524,219. At the same time the number of bad order cars was about 250,000, so that actually there were 275,000 serviceable cars not in use. Since that time the idle cars have decreased and bad orders have increased. On May 1 the car surplus was 482,076 and the bad order cars 309,971, making the net surplus of serviceable cars 172,105. On May 15 the idle cars had decreased to 450,164 and the bad order cars had increased to 324,969, the difference being only 125,195, or 46,910 less than on May 1. A surplus of 450,000 idle cars may seem ample to take care of any increase in business, but when the actual surplus of serviceable cars is only 125,000 it is time the railroads took notice of the situation. If the demand for cars continues to increase as it did during the first half of May and if the bad orders also increase as fast, the small surplus of serviceable cars will be exhausted before July 1 and there will be an actual car shortage with over 350,000 idle cars, but all in bad order.

It is evident that present conditions cannot be allowed to continue. The first step must be to reduce the number of bad order cars. There was a time when 4 per cent of unserviceable cars was regarded as a fair figure. When the ratio rose to 9 per cent in 1919, it was considered very serious and prompt measures were taken to reduce it. On May 15 the per cent of bad order cars was 14.2. If these cars required only minor repairs, they could be placed in service with little delay, but this is not the case. More than two-thirds of the total, 231,690 cars or 10.1 per cent of all the freight cars in the country, require heavy repairs.

What is to be done to improve conditions? In the first place, the roads must begin at once to repair the bad order cars. The number unfit for service should not be allowed to go any higher. A careful survey of the heavy bad order cars should be made and those that cannot be operated economically should never be repaired. In times of heavy traffic nothing handicaps operation more than the weak, obsolete car that limps from repair track to repair track and leaves a series of break-in-twos and train detentions along its path. The roads have been struggling along for several years without enough new cars to take care of necessary retirements and the normal growth of traffic and as soon as funds are available, they must secure a large number of cars.

The Locomotive Situation

LIKE the car shops, the locomotive shops have been running on short time and have scarcely kept up with the current demands for repairs. The number of serviceable locomotives stored is abnormally large, being about 12 per cent of the total owned, but some of these are good for only a few months' service. About 19 per cent of the locomotives are unserviceable, and if the resumption of business activity comes quickly, it will be difficult to get the large output to provide the needed motive power.

Shops Are the Neck of the Bottle

THE high percentage of bad order equipment is not entirely a development of the past five months. It is partly a heritage from last year when the business was the heaviest on record and the shops were not able to keep up with the work. The shops were actually the limiting factor in handling the traffic at that time. When business picks up, they will again be overtaxed. The locomotive and car problem is not only a question of equipment, it is also a matter of providing needed shop facilities. The repair plants must be improved to give them sufficient capacity to handle the work. They must be improved to reduce the cost of repairs, to permit locomotives to be equipped with devices to save labor and fuel and to make them adequate to handle modern equipment efficiently. There is reason to believe that there will soon be a revival of activity in the shops and with the resumption of work will come new problems in the management of the personnel and the equipment to get the best results. The keynote of the future is found in the first principle enunciated by the Labor Board "An obligation rests upon management, upon each organization of employees and upon each employee to render honest, efficient and economical service to the carrier serving the public." The June Shop Equipment Number of the *Railway Mechanical Engineer* is intended to point out some of the methods by which efficient and economical service can be obtained and it appears at a particularly opportune time to assist the roads in doing this.

Engine Terminal Development

ONE of the most important problems facing railroad mechanical departments today is the provision of engine terminals adequate in size and equipment to handle modern locomotives promptly and economically. Locomotives have outgrown terminal handling facilities, and many roundhouses that seemed to turn power efficiently ten years ago are now practically obsolete. This point is strongly emphasized in an article on the up-to-date roundhouse, published elsewhere in this issue and containing some valuable suggestions for the improvement of present terminal facilities. There is no gainsaying the fact that new, larger and better equipped engine terminals are needed and it is the consensus of opinion that the equipment should be such as to provide for all running repairs, both light and heavy, thus relieving back shops of this work which so disorganizes shop schedules. The difficulty is that capital is not now available for new terminals and the article referred to is particularly timely, therefore, as indicating capacity increasing improvements which will not cost much to install.

Attention is called to the need for keeping rough finished machine parts in stock, the finish operations only being performed at roundhouses. This insures furnishing the parts at a minimum cost and returning locomotives to service promptly. The replacement of worn-out turntable tractors, machine tools, air tools and jacks, while costing comparatively little, will do much to promote the efficiency of terminal operation. In this connection, the article contains the following striking statement: "The roundhouse is no place for *lame ducks* whether they be machines, tools or men." Reference is undoubtedly made to the all too common practice of transferring obsolete, worn-out machine tools from back shops to roundhouses with the expectation of getting machine work done more promptly and economically. The fact is that a machinist's time at a roundhouse costs just as much as at a back shop and a worn-out tool is as costly at one point as the other. All the refinements of production machines are not needed in roundhouses, but simple, rugged machine tools should be provided, capable of swinging any size of work ordinarily encountered and taking heavy cuts with the required degree of accuracy.

Other items, the need of which is self-evident, but can hardly be overstated, are mentioned in the article and include boilerwashing and refilling systems, monorail, radial and portable cranes, drop pits including engine and tender wheel pits and altered track layouts. The latter, as for example making a turntable accessible from both ends of the ashpit, can be made at small expense and often save many locomotive hours a day. In addition, where all terminal movements are made over one or possibly two switch points, emergency outlets should be provided to guard against delays caused by derailments at these points.

Particular attention should be given to the careful inspection and prompt repair of locomotive parts, making sure that all journals and bearings are periodically inspected and oiled. Probably the most important need of all is to develop able, efficient roundhouse forces, willing to co-operate with each other and the transportation departments in making locomotives earn revenue as large a proportion of the time as possible. Men of the required caliber cannot be retained in engine terminal service unless working conditions in many cases are improved. Reasonable working hours and adequate compensation are essential.

Making Foremen Local Managers

In his paper before the Car Foremen's Association of Chicago, dealing with the car foreman at the outlying point, L. K. Sillcox, general superintendent of motive power of the Chicago, Milwaukee & St. Paul, described some methods employed in the car department which have met with success in building up a close knit organization and which are worthy of the most careful consideration. There are two aspects to the success of these methods which at first sight are almost contradictory in their nature: First, the development of a closer knit organization, all units in which are working towards a common end; second, the development of a spirit of independence and self-reliance on the part of the local supervisors. A little consideration, however, will lead to the conclusion that these two aspects are not at all antagonistic and that in fact one is really corollary to the other.

There is a tendency in all railroad organizations, no less pronounced in other departments than in the mechanical department, to maintain an air of secrecy concerning the policies of the management, leaving local officers and supervisors to carry them out through the issuance of orders and rules which in themselves explain nothing as to the reasons for or the underlying purposes of the policies which lead to their issuance. This blind conduct of an organization depends entirely upon discipline for its success and in doing so it overlooks a big asset in the intelligence of the men in the field who must put these policies into effect. It is this asset which the methods described by Mr. Sillcox have been developed to utilize. The reports which the foreman at each outlying point must make are of no more value to the department management than to the foreman himself and their educational value is increased by the issuance of a monthly bulletin in which the results of similar operations for the road as a whole are summarized, thus giving each local foreman an opportunity to form an accurate estimate of his own relation to the road as a whole. One of the most important results seems to have been the development of a feeling of self-reliance on the part of these local supervisors who are able to manage their own stations in many respects on their own initiative, within the limitations prescribed, rather than to await the urge of official criticism from headquarters. In other words, discipline has been fortified by intelligence and the local supervisors have become local managers.

Train Accidents Investigated by the Bureau of Safety of the Interstate Commerce Commission in the last three months of 1920—October, November and December—numbered 34, and the summary of the reports of these investigations—No. 6—has just been issued. The list includes 13 rear collisions, six butting collisions and seven derailments.

COMMUNICATIONS

A Decision That May Be Misconstrued

Washington, D. C.

To the Editor:

I notice on page 267 of the *Railway Mechanical Engineer* for April, 1920, an extract from a decision of the Appellate Division of the New York State Supreme Court, headed "Boiler Inspection Act Does Not Apply to Locomotive Cab." This was true before the amendment of March 4, 1915, and inasmuch as this accident to Brown on the Lehigh Valley occurred in January, 1915, prior to the effective date of the amendment, hence the decision quoted. In looking up the full text of the decision referred to, I quote in part:

"The accident happened January 12, 1915, and the case therefore is unaffected by the amendment to the last mentioned statute which became effective later in that year. We think the Act of 1911 has no application to this case. It relates, not to the locomotive, but to 'the boiler of said locomotive.' Clearly not every portion of the locomotive is within the statute. A cab is no part of the boiler and to hold that the floor of the cab is appurtenant to the boiler is not only to stretch the meaning of that word beyond its proper significance as applied to a boiler of a locomotive, and also to inject into the statute a meaning not intended."

I am directing this to your attention for the reason that under the amendment of March 4, 1915, we believe that the cab and all of its appurtenances are a part of the locomotive and, inasmuch as the Locomotive Boiler Inspection Act as amended is commonly known as the Boiler Inspection Act, I thought possibly some of your readers might misconstrue the court's decision and act accordingly, which would bring us in conflict and which we are striving to avoid.

A. G. Pack.

NEW BOOKS

Proceedings of the International Railway Fuel Association, 1920. Edited by the secretary, J. G. Crawford. 480 pages, illustrated, 6 in. by 9 in. Bound in leather. Published by the association, 702 East Fifty-first street, Chicago.

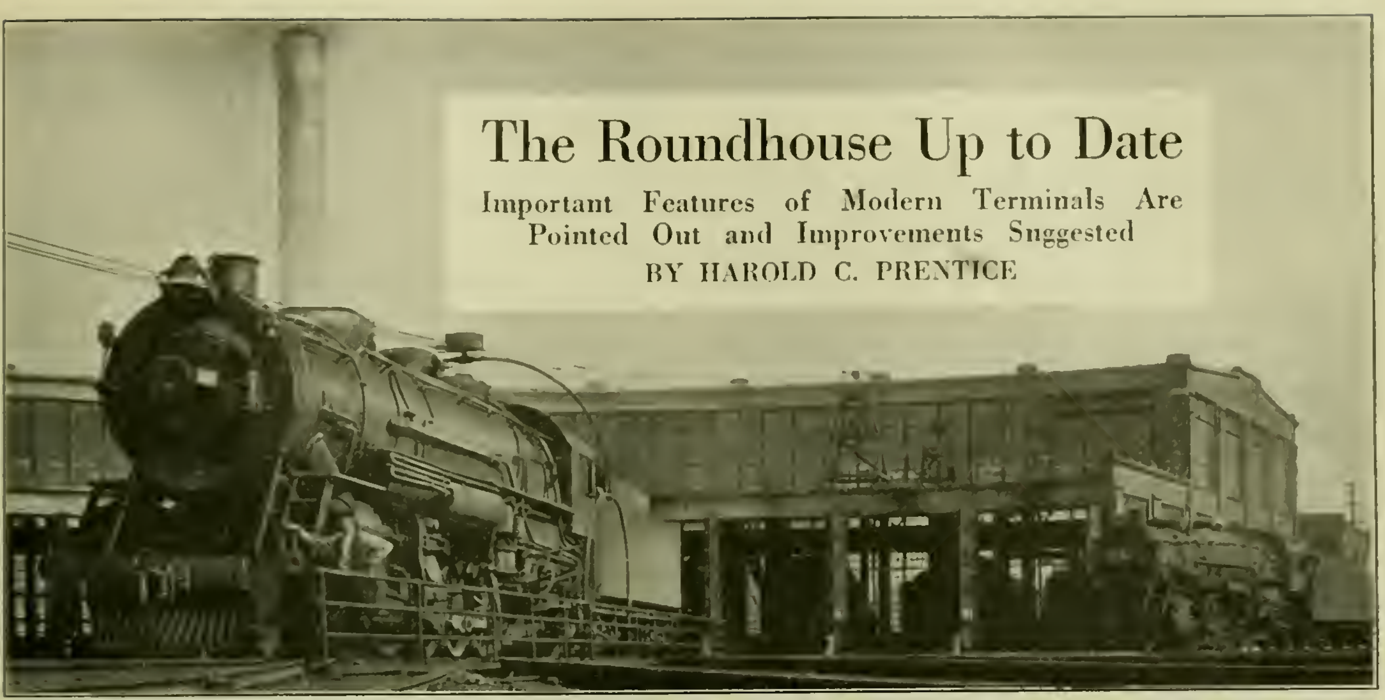
The proceedings of the twelfth annual convention of the Fuel Association, like the foregoing volumes, is a comprehensive and carefully prepared account of the meeting. Probably the most notable feature of this volume is the voluminous paper on Oil Burning Practice on the Atchison, Topeka & Santa Fe, by Walter Bohnstengel. This describes in detail the equipment and methods and gives a complete account of tests of oil fuel conducted by that road, forming a complete and well-rounded treatise on oil burning practice. The report of the Committee on Front Ends, Grates and Ash Pans is of interest because of the discussion of table grates vs. finger grates and the description of the Lewis drafting system. The comprehensive discussion in connection with the report on Pulverized Coal describes results obtained with some of the existing installations of this type of fuel.

The utilization of lignite and sub-bituminous fuels is discussed with particular reference to the carbonizing of lignite. The use of carbo-coal in locomotives is also the subject of an individual paper. Other committee reports deal with fuel stations, feed water heating and an address by E. G. McAuliffe reviews the fuel oil situation. Other features of the volume are the opening address by Roy V. Wright, editor of the *Railway Mechanical Engineer*, and an address by Mott B. Morrow.

The Roundhouse Up to Date

Important Features of Modern Terminals Are Pointed Out and Improvements Suggested

BY HAROLD C. PRENTICE



A Reliable Turntable Designed with a Large Factor of Safety Is Essential

LOCOMOTIVE development during the past ten years has been so marked that shops and roundhouses are in many cases obsolete when they seemed to meet the requirements but a short time ago. What will be expected of the roundhouse of the immediate future? What will be its relation to the back shop and to the railroad in general?

The first duty of the roundhouse is to furnish power to the railroad when needed; the next is to maintain this power between shopping periods. The back shop is designed to make classified repairs and produce standard parts and for efficient back shop operation the adherence to a schedule free from continual interruption by running repair work is essential. It is impossible to draw a hard and fast line between roundhouse and back shop work but it is generally assumed that tires, wheels, driving boxes, shoes and wedges, pistons, piston heads, valve bushings, bull rings, air brake equipment, injectors, lubricators, and all standard small parts will be furnished by the back shop. A still better arrangement is for the store room to furnish this material rough finished and it will then require but minor machining or fitting by the roundhouse organization.

This plan may be illustrated by the renewal of a driving box. Four men can drop locomotive wheels and remove a defective box in about two hours if the equipment is in good condition and there are no unusual circumstances. With a box on hand requiring only boring and facing, it can be placed on the boring mill in the roundhouse machine shop ready for machining as soon as the sizes can be taken, the machine operations being completed in one hour or less. During that time the four men have changed wedge liners or done other work that has developed and are ready to apply the box. In another three hours the wheels are in place and the rods applied, the entire operation including perhaps the renewal of a rod bushing or two, being performed in six hours.

If, on the other hand, the drop pit is tied up with another engine awaiting material and it is necessary to order a new box complete from the back shop the delays mount up. Possibly an engine at the back shop is overdue for wheeling in which case the general foreman does not like to delay matters longer by giving preference to roundhouse work. It also may develop that there is no machined driving box on hand and the new one will require complete finishing from the rough. The only solution is to have in stock at each roundhouse or adjacent storeroom rough finished machine parts ready for application to locomotives as soon as finishing cuts have been taken.

To the uninitiated who are disposed to criticise roundhouse operation the privilege of spending a day in a busy trunk line terminal would be enlightening. It is said that an important government official, having inspected a big but inadequate engine terminal recently, was in a decidedly critical mood all day until invited up into a tower overlooking the yard. There he saw train after train leaving on time with literally scores of engines lined up in turn to back onto other trains yet to go. Criticisms were immediately replaced by compliments. The common defects of old roundhouses are well known; tenders projecting through the doors in zero weather, too short turn-tables with obsolete tractors and mechanics called from inside to push heavy engines around; unhandy track layouts, pits half full of water, obsolete machinery, worn out air tools, jacks, hand trucks, etc.

Careful Inspection Needed

The secret of efficient locomotive maintenance is in periodical inspection and repair of all parts. In fact, this should be the foundation of any plan of operation. A comprehensive schedule of inspection and work, coupled with the regular assignment of mechanics to this duty alone will result in turning out power that will run until the next period with little attention between times. Working conditions will in many cases require a considerable modification if high grade men are to be retained. Leaky roofs, wet floors, poor lavatories and unclean conditions must be eliminated.

There can be no more profitable investment than the modern boiler-washing and refilling system which should extend to every pit. The supply of adequate steam pressure for blower lines and a sufficient supply of compressed air, must be had if repairs are to be promptly made and engines quickly steamed up.

There has been some discussion regarding the installation of electric traveling cranes in roundhouses. In most cases this would necessitate rebuilding but there is room for comparatively inexpensive improvement by installing monorail trolleys, radial cranes on posts, shop tractors and portable cranes. Pistons, cylinder heads, crossheads, air pumps and other parts have outgrown the two-wheeled truck.

Driving and Tender Wheel Drop Pits

The subject of drop pits is a live one. It is no less than suicide to neglect driving box repairs on locomotives now in use and this work requires adequate drop pit or jacking equipment, conveniently located in relation to the machine shop. The same is true of engine truck and tender wheel work. The practice of uncoupling and jacking up a tender in order to remove a truck and change a pair of wheels is extremely costly in this day of stokers, conduit connections and heavy draw-bars. Once the tender wheel drop pit is installed it will undoubtedly raise the standard of tender wheel maintenance on account of the greater ease of changing wheels.

There is room for improvement in the design of drop pit jacks, especially those intended for driving wheels. The plain air jack is dangerous and is being discarded. The method of supporting a pair of heavy drivers from the center of the axle can be improved upon by an arrangement that will enable the wheels to be dropped and placed back on the floor without leaving the rails. This has been tried out to some extent and should be perfected. Means should be provided to eliminate hand pumping of large hydraulic jacks.

The heart of the roundhouse is the turn-table. There are many terminals so built that the opposite tracks do not line up and when there is no small engine available, it is necessary to uncouple tenders of crippled engines to move them into the house and sometimes the same is required of the engine that does the moving. An inconvenient and somewhat dangerous practice consists of pulling the engine off the table with a cable or chain attached to the next engine. In some cases a windlass operated by the turn-table tractor motor would be of assistance in this work but the installing of a small locomotive for use in the circle is worth many times its cost to any fair sized terminal.

There are many places where quick turns of important power are made, and the turn-table is often held while these engines are in the house for a few minutes. It has been found that the construction of a shed with pits, work benches and a few other accessories will eliminate this delay and in some cases also be available for trial engines coming from the back shop. Many large terminals are constantly being crippled by men waiting a turn-table movement, and the cutting down of unnecessary turns, with the assurance of prompt service when needed will be invaluable.

Machine Tools Needed

The machine shop is deserving of more consideration than commonly given it. It is generally called upon for rush work and several different men may operate each machine in the course of twenty-four hours. Simple, rugged designs, therefore, should be considered in ordering lathes, shapers, etc., leaving the more complicated ones for back shop production work where they can generally be in charge of one or two regular operators. *The roundhouse is no place for "lame ducks," whether they be machines, tools or men.* As to just the equipment needed, that depends upon what and how much work is expected. Assuming that parts are furnished rough machined, the minimum required for a roundhouse turning from eighty to one hundred engines per day and maintaining about forty of them would be one heavy duty radial drill, one small drill press, one 36-inch boring mill, one 36-inch lathe long enough to take extended piston rods or tender wheels, three smaller lathes of different sizes, one 24-inch shaper, one bolt threader, one pipe threader, one 36-inch planer, an emery wheel, a grindstone, a vertical press, a forge and in some cases a steam hammer. One little thought of, but very useful and cheap machine, is the power hack saw.

Nothing can be more important than good and sufficient tools. The roundhouse tool room is just as important and should receive as careful attention as the back shop tool room. The list of what it should contain is too long to catalog, but in a word should include everything needed in doing the work easily and well. The tool room, regardless of the amount and quality of its equipment, cannot function without the aid of proper supervision. The attendant must be a man who will insist that no tools leave without a check and that they will be returned in due time instead of being hoarded in some locker. There are cases where men should be furnished with regular tools and every man should be able to do his regular work without too many trips to the tool room window, but the tools he is to have should be independent of the regular tool room supply and be determined by someone in authority.


Modern Arrangement by which Locomotives Can Take Water and Coal at the Same Time

It is too often the case that there are not enough work benches and a man must go some distance to find a usable vise. This condition should be remedied. Also, a liberal supply of low platforms, horses, and short ladders will remove the excuse for the dangerous practice of standing on wheelbarrows, trucks and other makeshifts.

The art of electric welding has been developed to a wonderful degree and it is gratifying to note the new installations in roundhouses of electric and oxy-acetylene welding equipment. Defects too numerous to mention are now being corrected without removal from the engine and the spectacle of men trying with hammer and chisel to cut off rusted bolts and nuts in unhandy places is becoming a thing of the past.

The exasperation of being unable to locate a foreman when needed is being overcome in other industries by the use of shop telephones located throughout the plant with signals for every important man. In this manner supervisors are always in touch with each other and the constant running of errands by high salaried men is dispensed with. Some such system should be devised for roundhouses.

Coupled with the subject of adequate equipment is that all-important one, the service of supply. Too much emphasis cannot be given to the importance of having material where and when it is needed. It is the duty of all supervision to anticipate needs for articles not carried in quantities and also to note any excessive consumption. Where storerooms are located at some distance from the roundhouses there should be auxiliaries for terminal needs placed near the machine shops and tool rooms.

Altered Track Layouts

Before an engine can be put in condition for service, it generally must be moved from the receiving point to its place in the roundhouse. The proper location of coaling stations, ash pits, and watercranes will receive due consideration in new construction, but there are many terminals now in existence that can be made to function more effectively with modifications in track layouts. One important terminal was much improved by moving about 75 ft. of track, which made the turn-table accessible from both ends of the ash pit when formerly it was necessary to make all movements on and off the same end when going to the roundhouse. The replacing of an obsolete turn-table tractor by a modern one of sufficient capacity further improved conditions, and the final installation of a 100 ft. turn-table increased the efficiency of this terminal in a marked degree.

Water Pit with Overhead Crane and Side Dump Cars Used for Handling Ashes

At some busy terminals all movements to and from the yard are made over a single switch point. This has often been the cause of hours of delay from derailments at or near this point. There should be at least an emergency outlet. While the financial condition of the railways makes the immediate investment of funds for badly needed terminal improvement uncertain, there are numerous things that can be done without great outlay to improve terminal operations.

Maintaining Locomotives

While no pains should be spared in planning terminal equipment, the fact should not be forgotten that, after all, machines and tools are but one means to the end of keeping locomotives in condition to earn money for the railroads. It is not always the best equipped shop that is the most efficient. To maintain locomotives today requires greater knowledge and more careful supervision than it did a few years back. Present day transportation demands large power units. The cost of fuel, oil, and labor necessitates doing everything possible for its conservation. It is but a waste of good money to install an expensive device and then fail to maintain it.

The superheater increases locomotive efficiency to a great degree provided it receives a reasonable amount of attention. The damper in particular should be kept in good operating condition. Flues must be kept tight and cleaned at regular intervals, all honeycomb and cinders being removed. In blowing flues a pipe no larger than ⅜ inch is used, as others will not work except when directly in line with the fire door. It must be pushed along the flue underneath the unit until it will blow out all accumulation.

The matter of lubrication is often neglected. Box packers, oil cup fillers; lubricator men, and mechanics on engine truck, driver, trailer or tender bearings should be properly trained and duly impressed with the importance of their duties. A hot wheel will tie up the most important engine just as quick and sometimes quicker than less important ones. No foreign matter should be allowed inside the box to work between the brass and the journal. Correct machining, true journals, proper alinement and a little oil on the brass will insure a successful job.

Tender oil boxes in time become worn in the crown and cause unequal bearing on the key. This should be ascertained when the brass is removed and a new box applied. Truck frames will sometimes become twisted and throw the weight on one end of the brass. This will be seen by close observation of the top of the key and may be corrected for the time being by placing a liner between the box and the arch bar on the low end. Many tender wheels that run a little too warm for comfort may be overcome in this manner.

A good box packer will not allow a cellar to run with much opening under the journal, or with waste hanging out and syphoning the oil away but will call attention to the matter. When a driving box is using a grease cake a trip, the fault will be located and corrected. If the rod cup man will see that spindles and dowels are in good condition the rods will run with much less grease and oil. There is no reason for a hot wheel except one—neglect. Careful selection and training of box packers will lead them to discover loose, worn babbitt linings and other defects of bearings and engine failures will be reduced to a remarkable degree.

Men competent to move engines in emergencies when the hostler is busy will reduce the time mechanics often are required to wait for a move. In cold weather there can be no more short sighted policy than that of not having sufficient men on hand at ash pits to clean fires and to watch engines. The delay in consequence of a dead fire or burst feed pipe will cost more than enough to pay for the extra man.

The Time to Cure Engine Failures

The time to cure an engine failure is before, not after it occurs. This is where adequate inspection comes in: to learn to look beneath the surface, to locate the unseen cause, to anticipate a developing weakness. For example, broken tender brake beam hangers or lost brake shoes will indicate a shelled tread or flat spot that in time will cause trouble. When it is impossible to maintain piston or valve stem packing, the trouble may be due to defects inside the cylinder or steam chest. Renewals of piston rod valve stem, cylinder and valve packings should be a matter of separate record for the purpose of noting unusual amounts of this work.

View Showing Covered Inspection Pits, Ash Handling Facilities and Roundhouse Proper

There is sometimes too much detail connected with getting a small job done. The inspector finds a loose nut or two, and goes to the office to report the item. A work slip must be executed and delivered to the foreman and then to the workman who performs the work. The slip is finally returned to the foreman for his signature and then must be checked and filed. This excess of detail is being overcome by the use of inspection pits at the receiving point where the inspector meets the engine and looks it over with the engineer. A small force, properly furnished with small parts, can do the little jobs under the supervision of the inspector and often the engine will not have to go into the roundhouse at all but will be ready for service as soon as the fire is cleaned and coal and water taken. If there are no inspection pits at the terminal in question the idea may be put in practice inside the roundhouse and repairs speeded up to a considerable degree.

The work report clerk as well as the inspector should be on the watch for items reported more than once after they are signed up as being done. This check will make it harder for the slovenly workman to get by. Slips of work undone are to be filed separately until after the boiler is washed when these items will be disposed of. A well kept work report file is a true guide to the condition of the power and to the effectiveness of the organization.

Need for Co-operation

Co-operation and mutual confidence between higher officers, foremen and workmen must be obtained or failure will result regardless of equipment or organization. Roundhouse work is spasmodic to a large extent and cannot be absolutely reduced to routine. In consequence, men are sometimes very busy and then again they may be temporarily unemployed. If at times when a man is out of a job he be permitted to loaf in a specified place that is in sight and convenient, he will be instantly available when the work comes in. He should in no case be allowed to get into cabs or out of sight. Men will, for self protection, hide away when the work is done if experience proves that they will be subject to harsh criticism or unjust discipline from some higher official than the foreman.

The roundhouse must have the support of the engineers and firemen and the only way to get it is by fair dealing and practicing the art of diplomacy. An occasional trip in a locomotive cab will be an education to many who are disposed to criticise these men for every little failure on their part. Friendship with the yardmaster and train despatcher will result in mutual advantage. To learn the viewpoint of the other fellow and to realize that he also is not without his troubles will make smooth many a rough road and be a help in time of trouble.

The very nature of roundhouse work makes it highly improbable that it can ever be easily performed. Men of highest ability are none too good for this important branch of railroading. Reasonable hours, good working conditions, and adequate compensation are necessary to attract them.

Frame Bolt Puller

The manual labor involved in driving out frame bolts by means of a punch and sledge hammer is well understood by all who have had occasion to remove bolts in this way. Another old practice in removing bolts and one which obtains even now in some shops is to shoot them out by means of a gun and powder. This method is more or less dangerous, however, and for that reason usually necessitates waiting until after working hours.

A device which has proved valuable in pulling frame bolts, particularly in difficult places where it would be almost impossible to swing a sledge hammer and where it would be dangerous to operate a gun, has been developed. This device is shown ready for operation in Fig. 1 and is said to require only approximately two minutes to set up and pull a bolt.

The operation of the device will be readily understood from an examination of Fig. 2. Two short rugged arms with inserted hardened jaws *A* are connected loosely by means of the pin *B* and key *C*. Provision can be made for pulling bolts with larger heads by using keys of different thicknesses. A small cylinder *D* is provided with a plunger having a triangular shaped head *E*. This plunger is operated by hydraulic pressure obtained by turning the long screw in sleeve *F*. The long screw is turned by an air motor and arrangements should be made for reversing the motor so that the screw can be backed out readily. One of the saddles *G* is applied over the head of the bolt to be pulled and transmits the pressure from the cylinder to the engine frame.

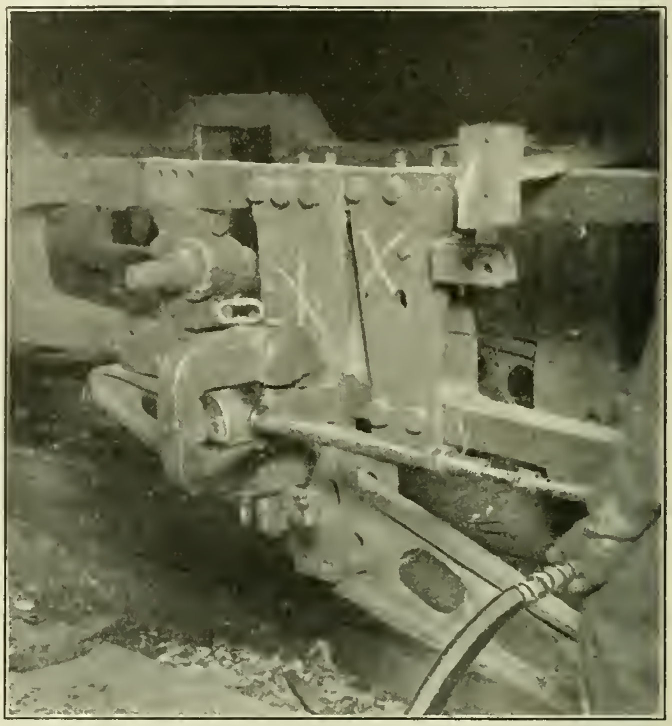


Fig. 1—View of Bolt Puller Set Up Ready for Operation

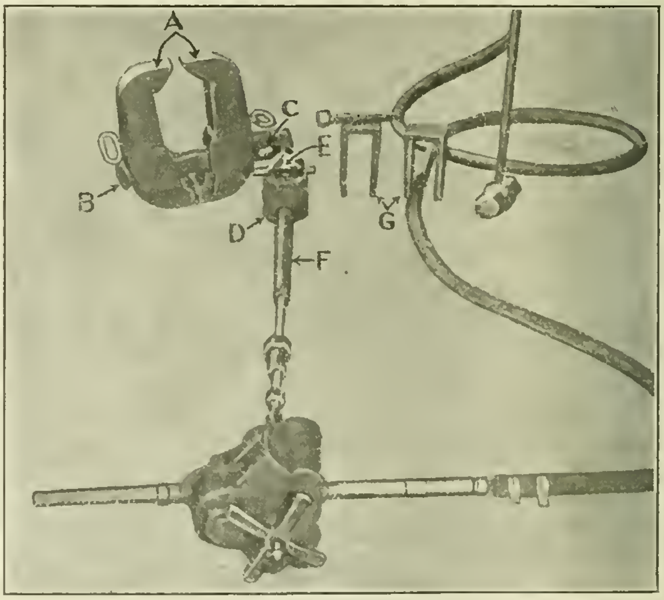
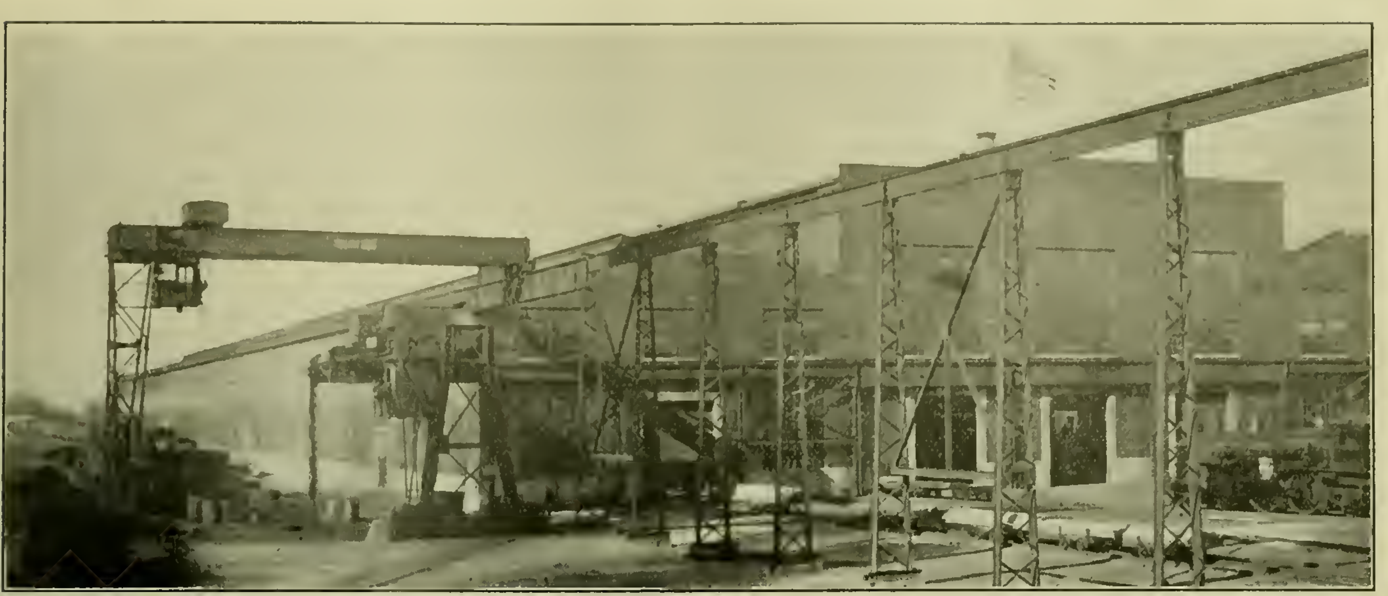


Fig. 2—Details of Device for Pulling Frame Bolts

Referring again to Fig. 1, the method of setting up this apparatus will be at once evident. The operation of the air motor increases the hydraulic pressure in the cylinder, forcing out the triangular shaped head with the following results. The jaws will be pushed together harder and the total force tending to pull the bolt will be increased at the same time.



West Burlington Shop of the Chicago, Burlington and Quincy

Revivifying the Railroad Shop

Modern Mechanical Facilities Will Inject New Vigor and Insure Efficient, Economical Service

BY G. W. ARMSTRONG

HONEST, efficient, economical service is the keynote sounded by the Railroad Labor Board in its recent decision. It sounds the public's challenge to both management and men to secure the best production at the least expense. It is a challenge to management to study and analyze shop facilities with a view to replacing obsolete, wasteful methods and equipment with modern facilities.

An Economic Balance Required for Increased Capacity

Increased capacity will be demanded of the railroad machine in the future. Increased capacity with economical service requires the greatest results from the least investment and the minimum expenditure of labor. Cognizance must be taken of the definite relationship between transportation requirements and the rolling stock and locomotives to handle the traffic. Either new equipment will be needed to provide increased capacity or more effective service must be obtained from existing equipment. The attainment of the most economical service to the public calls for determining the economic balance between the investment in new rolling stock and locomotives, with their attendant burden upon maintenance facilities, and the investment in additional and improved shop equipment and facilities to maintain effectively existing locomotives and cars.

Roundhouses inadequate to promptly turn power and maintain it; repair shops already overcrowded with work, partially filled with obsolete machine tools, are totally unfit to care for repairs to additional equipment. Replaced if necessary, rearranged as required, supplied with adequate modern tools and equipment these revivified shop facilities will accomplish much to secure increased capacity from the present investment. Every equipment unit more quickly returned to service lessens by that much the need for new equipment with its attendant additional carrying charges.

Excuses will not avail. Private management has been said to be on trial. It cannot meet the test unless the equipment can be maintained under the stress of heavy traffic. *What will the future answer?*

Arguments that greater production cannot be secured with improved tools have been used in the last few years with deadening effect on management efforts. Every evasion of responsibility on the familiar pretext: "It can't be done, because of piece-work abolition, national agreements, or what-not," is a psychological stumbling block to results. Private management to survive *must* secure results. Management *will* secure results and modern shop facilities will help supply their answer. Turret lathes or automatic machines must be employed where it is possible to operate them with economy. Modern high power lathes must be installed to replace obsolete, broken-down, slow engine lathes. Facilities in all departments must be improved and adapted to play their part in securing honest, efficient, economical service.

Equip Machines; Don't Merely Buy and Install

Machines alone will not suffice. Accessories, fixtures and jigs, adequate and well designed, must be supplied when the machine is placed in service. It is deplorable to see costly machine tools handicapped for the want of the small additional investment to equip them properly. The lack of a special chuck or fixture to hold the work often means that one-quarter or more of the total time required to finish the piece is needed to chuck it; while with adequate facilities this unproductive time could be cut to one-tenth or less of the total time.

The problem of designing and furnishing these required accessories, fixtures or jigs is often left to the local shop tool-room, which frequently is inadequately equipped even to keep abreast of the maintenance demands of the shop tool equipment. Worse yet is the condition where this work is done locally and charged to the small tool account, through inability to secure authority for purchases at less expense from qualified tool and fixture manufacturers because this would properly be classed as a capital expenditure and consequently require an executive appropriation. Locomotives would not be purchased without lubricators, air brakes or other parts required to make them complete. They are placed into service ready to perform; why not a machine tool also?

A Vision Required for the Future

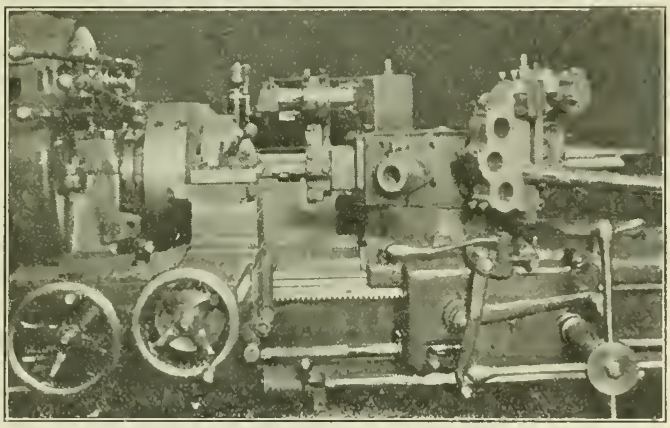
The need of the future is a vision, not of what has been used in railroad shops, but what with profit can be used there. The past decade has been one of intense development in industrial shop facilities. "Oh, my problem is so much different from the other fellow's that I can't use that" should not be a slogan with which the mechanical officer tackles the problem of future facilities. Instead it should be an eager, open minded striving to find out how conditions can be improved, or applications modified so that the best mechanical appliances available shall be employed in the maintenance of railroad equipment to the end that honest, economical, efficient service shall be insured.

The Machine Shop

Of foremost importance in the problem of modernizing shop facilities stands the machine shop. Careful study should be made of the work requirements of each tool to determine whether it is suitable for the purpose, whether it can be adapted to function properly or whether it should be replaced. The final result should be a tool adapted to quickly, accurately and cheaply perform its function in promptly returning equipment to service.

Turret lathes are commonly looked upon as machines for production work only and one or more of them will be found in nearly every shop finishing set-screws, studs and similar parts, which can be turned out far more cheaply on automatic screw machines. There is a field for both and each should be fitted to its place in the economical maintenance of equipment.

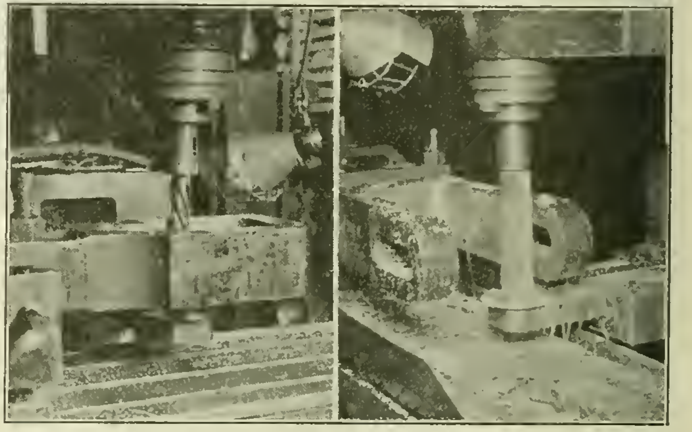
Turret lathes can be used with advantage for virtually all chucking work. A large proportion of the engine lathes found in the average shops are used continuously as chucking machines. The turret lathe with a side carriage carrying a turret tool post reduces the time required for changing tools and possesses the additional advantage that if more than one piece is required the stops can be quickly set for at least a rough approximation as to size, allowing quick roughing down with the usual calipering or measuring for finished size. While, of course, production time on a turret lathe requires a reasonable run of similar parts, the lack of quantity requirements does not preclude the possibility of profitable employment of turret lathes.


Turret Lathe Tooled to Machine Piston Valve Spiders

One railroad has even found turret lathes advantageous in roundhouse machine shops for finishing rod brasses and bushings as well as other chucking work and miscellaneous bar stock turnings. A dead center can be placed on one turret face if desired and the machine used as an engine lathe with a turret post, if provided with a side carriage.

A point in the selection of a turret lathe worth considering is to secure a machine with the greatest degree of universal application and the widest range with standardized tooling equipment.

Vertical boring mills with side heads and turret tool post boring heads have been introduced to a considerable extent in railroad shop operation. They have especially been found well adapted to driving box boring and facing, piston head and cylinder head repairs and piston and piston valve packing ring production. This type of machine, due to its centralized control and multiple tooling possibilities, combined with a complete cutting lubricant system (little used in railroad shops), has large opportunities as a "cost-cutting" tool.


Truing Main Rod Ends on Vertical Miller

The horizontal boring, drilling and milling machine is an almost indispensable adjunct. Aside from its usefulness on awkward jobs such as machining a steam pipe, its field lies in finishing those parts which require several successive operations, which on this machine can be performed with the same set-up. Thus parts similar to a slide valve steam chest can be quickly and economically finished, as they can be bored for the packing gland, drilled and tapped for the gland studs and faced with a face mill at one setting.

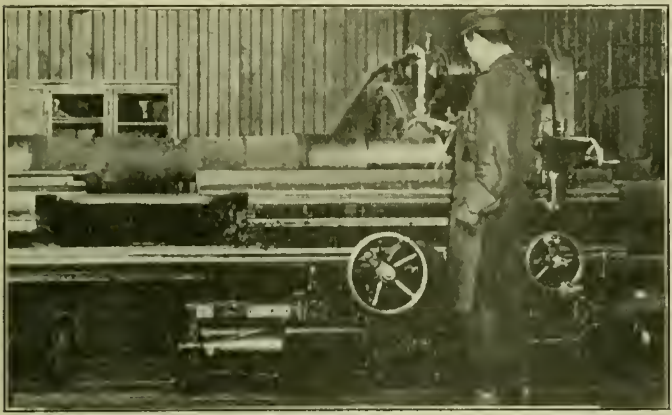
Heavy duty drill presses with cross feed or compound table have been profitably employed in some shops. This type of drill press can be used in many cases with the addition of simple chucking jigs or fixtures to replace engine lathes, boring mills and other machines, aside from its desirability as a rapid production drilling machine.

Milling machines are included among the production tools which have been largely neglected by railroad men. Heavy knee type milling machines as well as slab milling machines are available, which are astounding in their accomplishments as "hogs" for metal removing. Stress is too often placed in the avoidance of these machines on the expense involved in milling cutters. Contrasting the finished result and production time with the economy in floor space compared with other machines frequently required for the same work, cost of milling cutters does not become the drawback it is so often considered.

Cast steel driving box wedges have been milled on knee type milling machines in an average time of 15 to 18 min. floor to floor, finished complete as compared with an average of 40 to 45 min. upon a planer, machining the parts in large gangs and requiring three operations with a period of two to three weeks to finish them economically.

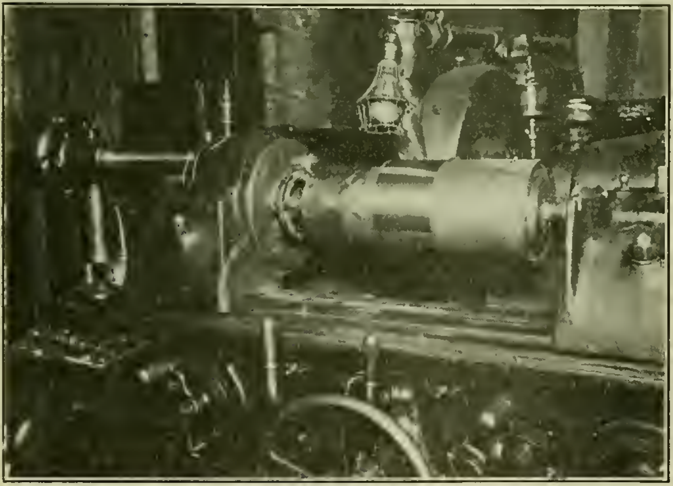
Front and back ends of main rods as well as main rod straps have been readily finished by means of a small diameter spiral mill on a vertical knee type milling machine so that only a slight amount of filing to break the sharp corners was required. The value of the true surface in rods repaired by this method is difficult to estimate, insuring as it does a much better fit of the brasses.

Grinding machines are another class of tools neglected in some railroad shops. The cylinder grinder, cylindrical grinder and surface grinder all have their possibilities, and large possibilities, in efficient and economical shop operation. Accuracy, minimum reduction of metal, superior finish, and workability of hardened surfaces are salient characteristics of the grinding process. Finishing many parts by the grinding process permits the reduction to a minimum of rough casting or forging weight which in case a considerable number of parts are used annually involves no mean item of saving. Exhaust nozzles can be ground from the rough casting, valve packing strips can be finished from the rough as well as crank-pin washers, driving box cellars, slide valve faces and numerous other parts without other operations being required.



Machine for Grinding Extended Piston Rods, Crank Pins, Trailer and Driving Axles

"Why should I finish by grinding, requiring two machines to handle, when I can finish it in the machine first handling it," is the usual query. If the work is properly prepared to be ground economically, the total production time is reduced. Turned parts to be finish-ground should be roughed out with a coarse feed (proportioned to the diameter) permitting rapid production in finishing.



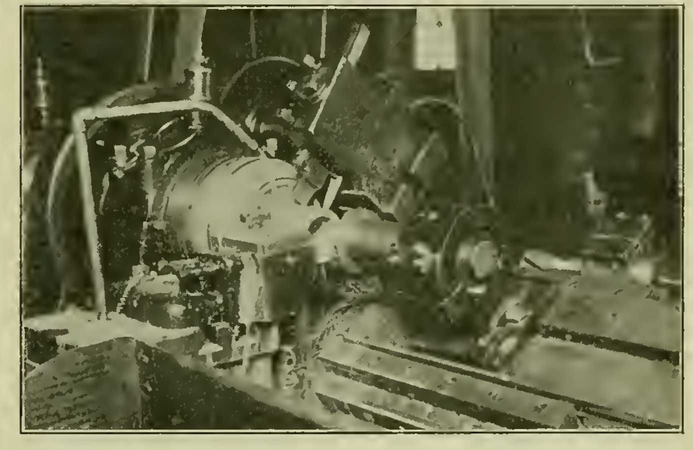
Truing a Crank Pin on a 10-In. by 36-In. Grinding Machine

Aside from any decrease in production time and consequently of production cost, is the accuracy of size control and superiority of finish. A ground surface possesses a greater density than a turned surface, which alone tends to give better service and greater life. Parts cannot be finished as accurately or quickly by turning as they can by grinding.

Ground pins used in conjunction with ground bushings permit of accurately supplying the proper clearance. One road has even considered this element of sufficient importance in motion work maintenance to warrant placing a number of 10 in. by 36 in. plain grinding machines in the roundhouse machine shops.

Cylinder grinders are being used to advantage not only in accurately and quickly grinding holes and bushings which could be bored but also in repairing parts which it would be virtually impossible to finish by any other process owing to the limited thickness of the wall. This type of machine is being used to grind bushings in all kinds of motion work parts, triple valves, knuckle pin bushings, link trunnions, automatic fire door cylinders, and numerous other parts.

Automatic machines have been installed by some railroads. Their possibilities in reducing maintenance cost have as yet, however, been but little appreciated. It is true that to secure the utmost economy from automatic machine operation reasonably long production runs must be scheduled for them but it is not impossible to employ them profitably on what would be considered in commercial work inadequate runs. Even if only one multiple spindle automatic screw machine can be installed in a shop and requires an operator for that machine alone; it is possible to operate it economically. Conservatively estimated, three times the production of a single turret lathe can be secured from one four-spindle automatic machine. Allowing for excessive loss of time to set up for short runs of work, and even idle time on the part of the machine, it is possible to secure an output equivalent to two turret lathes. Supplementing a multiple spindle automatic screw machine for small bar-stock work such as studs, rod dowels, etc. with a larger size single spindle automatic screw machine for motion work pins, bushings and other kindred parts, it can be readily seen that with one operator for these two machines the possibilities for economical operation are very much increased.



Single Spindle Automatic Making Motion Work Bushings

Automatic chucking machines virtually duplicate turret lathe chucking practice as far as set up and tooling are concerned. The main modification lies in the mechanical performance of the work cycle rather than the manual performance, thus permitting one man to operate two machines. This type of machine can be used very advantageously for finishing air pump piston heads, piston valve packing rings, oil cup covers, crank pin washers, front end main rod washers, boiler check bodies, valves, and similar parts.

Heat Treatment of Tools

To realize the benefit of modern machine tool equipments it is essential that proper heat treatment of the necessary tools be secured and that this heat treatment is directly under the control of the toolroom foreman. Pyrometers should be used to measure the heat, the scleroscope to check the degree of hardness and easily controlled heating and drawing furnaces used to insure uniform, satisfactory results. Gas furnaces can be mechanically controlled to maintain a uniform temperature while there are a number of good electric hardening furnaces on the market giving a very delicate range of control.

Blacksmith Shops

Drop hammers—Standardization of parts and the reduction of weight of parts are both in line with progressive equipment design and maintenance economy. Standardization makes the drop hammer possible while the use of drop forgings as a substitute for castings permits reduction in weight without sacrificing strength. It is possible by the drop forging process to secure greater strength with less metal than by any other forging process. Much of the work suitable for drop forging can be done with the forging machine. But as stated, drop forging makes possible in many cases a reduction in rough forged weight, and also frequently the production of an article requiring little or no machining to prepare it for use. Crank pin collars can be readily forged, requiring only to be surface ground on one or both faces to be used. Oil cup covers, coal picks, cylinder cock valves, rod keys, all can be drop forged under a drop hammer not larger than 2,500 or 3,000 lb.

Hammer Heading Machines—Many of the bolts used in large quantities in car repairs and in considerable quantities in the locomotive department can be more cheaply manufactured by hammer heading machines having increased capacity over the average type of forging machine. Supplementing improved heading methods with modern, properly designed, high-speed thread cutting machines, bolts can be produced with less expense, with better shaped heads and accurately cut threads, which will insure greater holding power.

Bolt Turning Machines—There is also another large field for development in the production of bolts. With careful study, the use of a tapered bolt, and the maintenance of standard gages and reamers, it is possible to effect large economies in the cost of fitted bolts besides insuring a better fit because of an accurately turned bolt and a properly reamed hole. One man can operate a four-spindle bolt turning machine, and allowing for time lost in setting bolt turning heads, regrinding cutter blades, idle time, etc., it is possible to turn out at least twice as much work as by the usual bolt turning lathe.

The Boiler Shop

Hand flanging of sheets is the method still used in a great many boiler shops. The expense of large, powerful hydraulic flanging presses cannot be justified in the average shop, owing to the excessive overhead charges and the restricted use. Nevertheless, it is possible to virtually eliminate hand flanging of boiler sheets and oftentimes car sheets. By means of a pneumatic flanging press all outside flanges can be finished on flue sheets, door sheets, other boiler parts and car shapes. An additional advantage is that sheets as thick as 3/8 in. or 1/2 in. can even be flanged cold. Inside turned flanges such as door-holes still, however, require to be flanged by hand unless some type of hydraulic press is available, owing to the large throat of the machine required to take in such work combined with the sharp radii of such flanges.

New and heavier locomotive equipment has introduced a problem in a large number of shops in the preparation of boiler sheets. Existing shears and bending rolls have been found of insufficient capacity to take care of the heavy plates demanded for large power. New and larger bending rolls furnish the only answer to one need. Shearing problems, however, can be solved by the introduction of new methods, which are receiving wide consideration in the plate and boiler construction field and have been introduced to some extent by at least one railroad. Mechanically-actuated traveling gas cutting torches have proven very efficient in shearing these large parts. The torch is fed along mechanically at a uniform rate, and it is possible to secure an edge, either beveled or at right angles, which is smoother than the average sheared edge. Other mechanical and pantograph devices are available for trimming the flanged sheets to a beveled edge to facilitate caulking or for cutting out sheets of irregular shape.

Electric Spot Welding—Ash pan assembling has been simplified in at least one railroad shop by the use of an electric spot welder. This reduces the work of laying out and punching holes for rivets and riveting, to the one operation of spot welding with the machine. The electric spot welder has also been used successfully in assembling locomotive jackets, various kinds of tinware, etc.

Welding Tubes and Flues—Another application of electric welding which has as yet been little employed is the butt welding of tubes and flues. This insures a good, sound weld, permits the welding of safe-ends of any length, gives a compact and clean outfit, comfortable for the workman to handle, and heats the two abutting ends to a welding heat in the full view of the operator. Another interesting characteristic is that it refuses to weld tubes which have become too thin, as the tube will burn before the standard safe-end is brought to a welding heat.

Another important development in flue welding is the use of a machine holding the flue rigidly clamped and applying the pressure to weld flues with an expanding roller. This method of welding has been found very efficient and leaves a flue which is perfectly smooth inside and outside. It also permits the reclaiming of old flues by welding a flue of considerable length to the portion of the original flue left after removing the safe-ends.

Complete Modern Tool Heat Treating Department

Car Department

Progress in the car department has been marked by the construction of shops equipped with overhead traveling cranes and electric hoists to facilitate the repairing of cars. In addition there is growing recognition of the necessity for ample equipment of radial drills, bulldozers, forging presses, and punching and shearing machinery to adequately take care of the needs in this department. The greatest need in this field is for the further development of well-equipped car repair shops, permitting repairs to be made wholly under cover during inclement weather.

Among the developments, as yet limited, is the use of portable electric drills to relieve overloaded air compressor units. Compressed air distribution involves large losses in power owing to frictional resistance in air flow through piping systems, leakage, water content, at least under some weather and temperature conditions, and the inefficiency of the power units (compressor and hammer or motor); making it the most expensive power transmitting medium available in shop operation. Pneumatic hammers must still be used for riveting steel cars. Pneumatic motors can be replaced by electric drills, increasing the potential riveting capacity of the car repair yard or shop; and employing a cheaper power medium and one transmitted with greater effectiveness and decreased power loss.

Mechanical Handling Devices

Mechanical handling devices have not received the consideration which they warrant, in view of the high wages and poor control of common labor. Roller conveyors have been used to advantage in some shops for handling car journal brasses from the tumbling barrels to the boring machine, from the boring machine to the lining table and thence to the inspection table or loading space. Other small units have been used with advantage in transferring work requiring two operations from one machine to the other without the necessity for handling by other workmen.


Electric Tractor Hauling Bolt Wagon Train

For handling sheets while punching or shearing, an interesting adaptation of roller conveyor has been installed in car shops. Standards made of about 1¼ in. pipe have been embedded in the concrete floor spaced about 30 in. to 36 in. apart. In the upper ends are inserted roller casters capable of rotating through 360 degrees to permit easy movement and swinging of the sheet. The height from the floor to the top of the roller caster is of course the same as the working height of the machine throat. The average sheet brought from laying out or other operations by the traveling crane and placed on these rollers, can be readily handled by the machine operator without assistance.

Portable belt conveyors have been used for unloading and transferring brick, sand, coal and other materials around shops and storehouses. These machines can be supplied with electric motor or gasoline engine drive and are therefore suitable for use anywhere desired. Portable mechanical hoists are available, which can be used with profit in stacking material in the storehouse and material yards. Elevating motors, placed on a bracket or suspended from the ceiling, are also extremely handy.

Electric and pneumatic geared hoists have a wide range of application in handling material from the floor to the machine. They are quick acting, safe and easily controlled, permitting close adjustment in hoisting height. Monorail traveling electric hoists are very desirable for handling material from casting storage platforms, car wheel and axle storage platforms and other places to the machining department. They have also been found very advantageous for the transfer of material around through the shops which would otherwise require to be trucked from one electric traveling crane to another.

Electric industrial trucks and tractors have been found to be very profitable. One railroad repair shop has even found it advantageous to install suitable concrete walks connecting all shops to facilitate the use of these electric trucks.

The tractor possesses a decided advantage in that trailer trucks can be used suitable for the need of the particular material to be transferred. In addition they can be taken with the material to the machines or storehouse and the material disposed of without additional wasteful handling.

One shop has devised an interesting series of trailer wagons for use in its bolt manufacture. A flat top wagon with stakes at the ends is used to receive the blanks at the shears eliminating handling at this point. When forging the bolts they are taken directly from these wagons, placed convenient to the forging furnace, and as headed dropped into hopper wagons in which they are transferred to the bolt cutter. As cut they are dropped into an empty hopper wagon placed on the opposite side of the bolt cutter and are ready for transfer to the storehouse. Throughout the entire process of manufacture advantage is taken of the necessity for the workman to handle the pieces to load and unload them.

Electric industrial trucks equipped with cranes will be found especially adaptable for some uses, in particular roundhouse material handling or other places where hoisting facilities are not available or difficult to use. Heavy castings, locomotive or car parts can be frequently removed from place, put on the machine, transferred and replaced by means of this type of truck, requiring a minimum of common labor.

Conclusion

It would be impossible in the foregoing to give any specific remedy for revivifying railroad shops. Weak and strong points on different railroads and in different shops on the same road are so at variance that a general treatment can only sketch some of the means available for solving the problem. Each individual condition requires different treatment; each individual need must be carefully studied with the fundamental guiding principle of striking the economic balance between shop capacity and motive power or rolling stock in enlarging railroad traffic capacity to the end that honest, efficient, economical service shall be insured to the public.

There is given below a list of some of the more important articles which have appeared in the *Railway Mechanical Engineer* covering more fully the subjects which have been briefly discussed in the foregoing article.

GENERAL SELECTION OF MACHINE TOOLS:
  The Selection of Machine Tools....................Page 292, June, 1917
  The Selection of Machine Tools................Page 89, February, 1916
AUTOMATIC MACHINES:
  Automatic Machines an Aid to Economy............Page 344, June, 1920
  Automatics in Railroad Shops....................Page 303, June, 1919
GRINDING:
  Economies Possible by Car Wheel Grinding..........Page 355, June, 1920
  Grinding in Locomotive Shops ....Page 629, November, 1918
  Plain Cylinder Grinding Work...............Page 641, November, 1917
  Grinding and Milling Work.......................Page 309, June, 1917
  Grinding Car Axles.........................Page 152, March, 1912
MILLING:
  Milling Practice in Railway Shops.............Page 521, September, 1918
  Plain Knee Type and Similar Milling Machines....Page 41, January, 1918
  Milling in Railroad Shops......................Page 321, June, 1917
  Grinding and Milling Work......................Page 309, June, 1917
  Milling Machine Efficiency...................Page 593, November, 1914
HEAT TREATMENT OF TOOLS:
  Heat Treatment of Steel in the Toolroom..........Page 39, January, 1920
  Modern Tool Room Heat Treating Plant............Page 389, June, 1920
  Methods Used in Heat Treating Steel..............Page 236, April, 1920
  Heat Treatment of Steels.....................Page 655, October, 1920
  Electric Furnaces for Tempering Tools..........Pages 423, August, 1916
  Tempering Tools with the Electric Furnace..... Page 590, November, 1915
  Types of Pyrometers and Their Uses..........Page 663, November, 1919
ELECTRIC SPOT AND BUTT WELDING:
  Spot Welding Railroad Tinware..................Page 151, March, 1919
  Operation of a General Flue Shop (describes electric flue welder)
  Page 653, December, 1916

BOLT MANUFACTURE:
  Bolt Manufacture in Railway Shops..............Page 465, August, 1918
  Turning Engine Bolts...........................Page 193, April, 1915
MISCELLANEOUS:
  Power Tests of Machine Tools.....................Page 294, June, 1917
  Accuracy in Locomotive Repairs...............Page 673, December, 1918
  Micrometer Calipers in Railway Shops........Page 597, September, 1920
  Case Hardening of Steel.....................Page 675, November, 1919
  Case Hardening of Steel.....................Page 731, December, 1919
  Cutting Cost of Exterior Car Cleaning............Page 460, August, 1918
  Machining Car Wheels and Axles..............Page 453, August, 1917
  The Bulldozer in Railway Shops................Page 77, February, 1913

Economic Advantages of Large Freight Locomotives*

A Thorough Study of the Effect on Various Items of Expense Is Necessary to Determine the Most Suitable Type

BY A. F. STUEBING
Managing Editor, *Railway Mechanical Engineer*

PROBABLY the briefest presentation of the advantages of large locomotives is that made by James J. Hill: "Receipts are by the ton and passenger mile; expenses are by the train mile." It is not to be expected that such a general statement will hold good in all particulars, nevertheless it is true that a large proportion of operating expenses decrease as the train load increases, although not in the same proportion as the decrease in train miles. Under the operating conditions existing on most of the main line mileage of this country, the greatest possibilities for economy probably still lie in the adoption of locomotives of high capacity.

The large locomotive, designed merely for high rated tractive effort, is not a panacea for operating troubles. The first requisite is a design suited to the conditions of the operating territory, the traffic and the service. The relative advantage of specific designs is a problem in the economics of operation that must be solved by the application of engineering principles. It is a question of adapting the design to the operating and economic conditions and then co-ordinating the motive power with other facilities. The last requirement is of great importance for unless all the varied operations can be kept in step, the machine as a whole cannot run smoothly.

The adoption of improved motive power should be only one part of a co-ordinated program. Every appropriation for larger engines should carry with it, as an integral part, provision for facilities to insure the maximum utilization of the power. Engine terminals, shops, yards, the rolling stock and the track structure itself should be prepared to assist in obtaining the proper operating results. The co-ordination of facilities deserves careful study.

The Selection of Motive Power Has Far-Reaching Effects

The choice of motive power is of extreme importance because the characteristics of the power affect the earnings more than any other single factor and determine the efficiency of operation usually throughout the life of the engine. The problem of introducing new locomotives is similar to the problem of reducing grades and should be studied as thoroughly. The interrelation between the various factors affected affords large opportunities for savings and also for losses. No executive should be satisfied with a superficial analysis of the probable effect of a new type of power on operating costs. This is one of the problems of operation that has often been studied in a general way, but has seldom been analyzed quantitatively. The writer has made an attempt to develop a general method of determining the savings that might be expected from the use of high capacity locomotives, but at every step was so hampered by lack of accurate information that the conclusion was finally reached that there is no method of solving the problem without extensive research. Many investigations have been held up during the past few years, and the rapid changes in prices have made earlier data inapplicable. It would seem, therefore, that there is a large field for research in the economic problems of operation when normal conditions are restored.

A Shortcoming of Operating Statistics

The operating statistics as compiled at present are valuable for the analysis of existing conditions, but they furnish little information as to what would happen under other conditions. Thus the predetermination of operating results, which is most important from the standpoint of improved operation, is largely dependent upon the researches of the individual roads and of engineering organizations. Vast numbers of unrelated figures are compiled, but they are of little benefit in the solution of the general problem. What is needed is not merely a statement of the expenses under fixed conditions, but the rate of change of expenses under certain varying conditions, such as train load and speed. If such data were available, the analysis of operating results could be made more truly a diagnosis, rather than a mere post mortem. The investigation referred to above brought out numerous aspects of the economics of operation that apparently merit attention and a few comments on these points may be pertinent.

Many Factors Affect the Economic Value of the Locomotive

Most of the available reports on the economic value of large locomotives consider comparatively few of the items affected. The comparative costs of wages of train crews, of fuel and water and of repairs to locomotives are often the only items considered. In some few cases the comparative mileage and fixed charges on the investment in motive power have been computed. This is not sufficient to determine conclusively the relative merits of various types of power. The locomotive has a direct or indirect influence on many items of expense in the maintenance of way, maintenance of equipment and transportation accounts. The real problem in determining the value of a locomotive is to find the effect that its operation will have on the sum total of these accounts. The complexity of the problem has apparently often deterred railroads from giving it detailed consideration. However, it is a matter that goes to the very heart of the problem of economical operation and the results of a thorough study should more than justify the labor involved.

It is the purpose of the following paragraphs to point out some aspects of the problem that apparently are deserving of attention. A search through the literature on this subject has failed to disclose fundamental data on these questions that is applicable to present conditions.

The Effect of Motive Power on Maintenance of Way Expenses

Some roads have reached adverse decisions on the adoption of 2-10-2 type locomotives on the ground that the increased cost of roadway maintenance resulting from their use would more than offset the savings in wages. This opinion does not seem to be generally held, but as one of the arguments against heavy locomotives, it deserves recognition. Maintenance of way expenses make up about 17 per cent of the total operating expenses, but the greater part of the expenditures are independent of the character of the power. Much of the work of track maintenance is made necessary by the action of the elements, or by the necessity of maintaining the permanent way in suitable condition for fast passenger traffic. The expenditures which are most directly affected by heavy locomotives with long, rigid wheel base are rail, ties and track laying and surfacing.

There is little or no information available as to the comparative effect of four and five pairs of coupled wheels on rail wear and the other accounts affected. The more rapid wear of tires indicates that the effect on the rail is appre-

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*A paper presented at the Railroad session of the Spring meeting of the American Society of Mechanical Engineers, Congress Hotel, Chicago, May 26.

ciable and the tendency to straighten out the track, no doubt, increases the cost of maintaining it in line. The actual effect will vary according to the wheel base, the curvature of the road and whether the locomotive has one or more pairs of drivers equipped with lateral motion devices.

The sum of the maintenance of way expenses which may be increased by heavy motive power is about 10 per cent of the total operating expenses and if the effect is to increase these items considerably, the saving will be difficult to make up in other accounts. However, if the wear and tear on the track is merely proportional to the weight of the engine, as is sometimes assumed, light and heavy engines would be on a par as regards these items. The difference of opinion on this question suggests the necessity for a careful investigation.

Maintenance of Equipment

In any study of locomotive operation the cost of equipment maintenance deserves careful attention. The percentage of the total operating expenses falling in this classification has shown a fairly consistent increase over a considerable period. Locomotive repairs and renewals, which in 1898 amounted to 5.9 per cent, in 1918 had increased to 11.7 per cent. So many factors may influence this ratio that no definite conclusions can be drawn, but it is significant nevertheless.

The principal difficulties in maintaining large locomotives are due to the short life of driving wheel tires, driving boxes and main pin bearings. With the proper facilities and proper construction the work of caring for these parts becomes merely a matter of routine running repairs, but where the lack or inadequacy of terminal facilities hampers repairs, the loss of service due to these minor items may become serious. In extreme cases the mileage per month may be reduced so much as to make the fixed charges per ton mile unreasonably high. It is hardly necessary to point out that this should not be charged against the locomotive itself.

While the foregoing remarks are confined to some of the more important items of roundhouse maintenance, they are equally applicable to the work of classified repairs. If the shops and shop machinery are not adequate for new power, repair charges will be high and the time out of service will be increased. The cost of these facilities should be considered when estimating the saving that may be effected by new power. The shop should be regarded as an accessory that is essential to the efficient utilization of the large investment in motive power. Too often the question is decided on the basis of the direct saving on repair operations, without considering the value of the locomotive days saved by proper facilities.

Wide differences of opinion appear to exist regarding the relative cost of maintenance and mileage of 2-10-2 type and Mallet locomotives. While the field for each is to a certain extent distinct, there are districts where either might be suitable and roads that have sufficient data to permit a fair comparison could perform a service by furnishing information that would clear up this question.

Long Trains May Increase Car Repair Costs Considerably

A very serious problem in connection with the use of locomotives of high capacity is the effect on the cost of repairs to freight cars. The total amount spent for repairs and renewals is nearly as great as the repairs and renewals to freight, passenger and switching locomotives combined. When the length of trains is increased beyond a certain point, break-in-twos, shifted loads and damage to the cars in general may increase at a rapid rate. It is not inconceivable that the expense resulting from hidden damage may nullify savings in other items. Local conditions determine whether or not this is an important factor. The effect of increasing the length of the train would be but slight where short heavy trains of steel cars are hauled. It may be serious where the road cannot control the character of equipment in the trains, where the car load is light, the train long and the lading is subject to damage, or of such a nature that it may shift and damage the car. It is significant to note that the study of the operation of Consolidation and Mikado locomotives made by N. D. Ballantine showed the time delayed due to car failures was more than twice as great with the Mikado engine, which had a tractive effort of 57,000 lb., than with the Consolidation of 39,000 lb. tractive effort. No record is available of the cost of repairing the cars involved in these failures nor the defects noted at terminals that were chargeable to unavoidable shocks incidental to the operation of the longer train.

A study of car failures in long trains may demonstrate that the trouble is largely due to equipment with weak underframes. The greater portion of the damage is done to the draft gear and sills, and it is doubtful whether sills meeting the recommendations of the American Railway Association would fail except under the most extreme stresses set up by surging in trains. If wooden underframes are a serious hindrance to the operation of long trains, the remedy can be applied with little difficulty. While the reinforcement of the remaining cars of this type still in service would require fairly heavy expenditures, it would no doubt be justified by the saving in repair costs and the improved operation that would result.

Transportation Expenses

The character of the motive power has a decided influence on the expenses falling under this head. Directly or indirectly, the locomotive affects items in the transportation expenses which amount to about 35 per cent of the total operating expenses. However, some of the accounts seem to be affected only slightly and the importance of locomotives, which are merely capable of delivering high tractive effort at low speed in reducing transportation expenses, has, no donbt, often been overestimated.

Two of the important items which are reduced almost proportionately as the tractive effort increases are wages of train enginemen and trainmen. The economies in these expenses are considerable and they can be predetermined with a fair degree of accuracy. Probably for this reason they have assumed undue prominence. In the year 1918 the wages of train employees amounted to 10.5 per cent of all operating expenses. The fuel bill for road engines was practically as much. The cost of locomotive repairs was even greater and freight car repairs only slightly less.

Relative Importance of Fuel and Wages of Train Crew

Some of the costly measures necessary to obtain slight increases in the train load can probably never be justified on the basis of the savings in the wages of train crews and some of the related savings are problematical. Railroad officers when considering means of promoting economy might well keep in mind this thought: The gross saving due to a given percentage reduction of the mileage of train enginemen and trainmen under average conditions is equalled by the saving due to a like reduction in the consumption of fuel.

Passing to the consideration of the relative fuel consumption of heavy locomotives, each increase in size results in slightly better fuel performance, provided that similar care is used in the design. The essential features of an efficient boiler are large grate area, ample firebox volume and tubes of suitable length to prevent excessive losses in the waste gases. All these can be obtained in the 2-10-2 type or other heavy locomotives. The large cylinders used with such power are also advantageous because the smaller ratio of the area to the volume reduces the heat loss in the cylinders. Within the range of normal operation, however, the difference in the fuel consumption per unit of work with a well-designed locomotive of the 2-10-2 type and the Mikado type, for example, is probably negligible. The remarkable fuel performance credited to some designs of Mallet compound locomotives suggests the advisability of establishing in as conclusive a manner as possible the comparative results of this type of compound and typical large simple engines.

Some Items of Expense That Have Been Given Little Attention

The expenses directly chargeable to train service aside from fuel and wages, include lubricants and locomotive and train supplies. These items are of less importance than those previously mentioned and, in general, the charges per ton mile decrease as the tractive power increases.

The expense of yard operation is seldom considered as being influenced by the character of the road engines. In hump yards the cost of switching is probably independent of the length of the train. However, in drilling yards the necessity of hauling long cuts of cars reduces the speed of switching and increases the fuel used. While the net result is largely dependent on local conditions, this factor is of some importance and should not be passed over lightly in analyzing problems of operation with heavy power.

Enginehouse expenses likewise are affected by the character of the power to an extent depending on local conditions. The reduction in the number of units handled will cause a slight decrease in the cost per ton mile unless the new equipment requires additional facilities.

While the major items of operating expenses which enter into the problem of large locomotives have been discussed above, it is pertinent to enumerate several miscellaneous items which are affected to some degree. These include accounts affected by collisions and derailments, loss and damage, damage to live stock, clearing wrecks and injuries to persons. The effect of car failures on loss and damage has already been mentioned. Insofar as these expenses are due to collisions and derailments, they are increased by an increase in train density, rather than by an increase in the length of the train and would therefore be reduced by the use of locomotives of high capacity.

Fixed Charges

The only fixed charges on road and equipment which appear in the operating expenses are the depreciation charges on certain parts of the plant. While the separation of interest charges from labor and material may be desirable in the general balance sheet, the analysis of the advantages of various facilities is best made by considering the net amount that can be earned above the prevailing rate of interest.

The fixed charges on the motive power seldom exceed three to four per cent of the operating expenses. The difference between the fixed charges on a thoroughly efficient modern engine and a crude design that might be bought to make an insufficient appropriation cover a given number of locomotive is negligible. However, the difference in the earning power of these two types is quite appreciable and serves to show what large returns can be derived from the additional capital expended for refinements and accessories that give increased capacity and efficiency.

Reference has already been made to the advisability of considering the capital expenditure required for related facilities when deciding on the type of power. At first thought it might seem that the additional investment for terminals, shops and shop machinery would add greatly to the capital expenditure and the fixed charges. Under ordinary conditions the cost of roundhouse space required properly to house a locomotive is a comparatively small proportion of the cost of the power. The cost of the shop buildings and machinery is even less important when the added efficiency and decreased cost of repair operations is considered.

Sometimes the introduction of heavy locomotives necessitates strengthening or replacing bridges or laying heavier rail over certain sections. The expenditures involved are often quite large, but the relatively long life of these structures decreases the fixed charges and the additional cost per ton mile becomes comparatively small and is seldom an important factor in determining the most economical equipment. When new rail must be laid the additional expenditure is a more serious item and the charge would probably not be justified except on a line with relatively dense traffic.

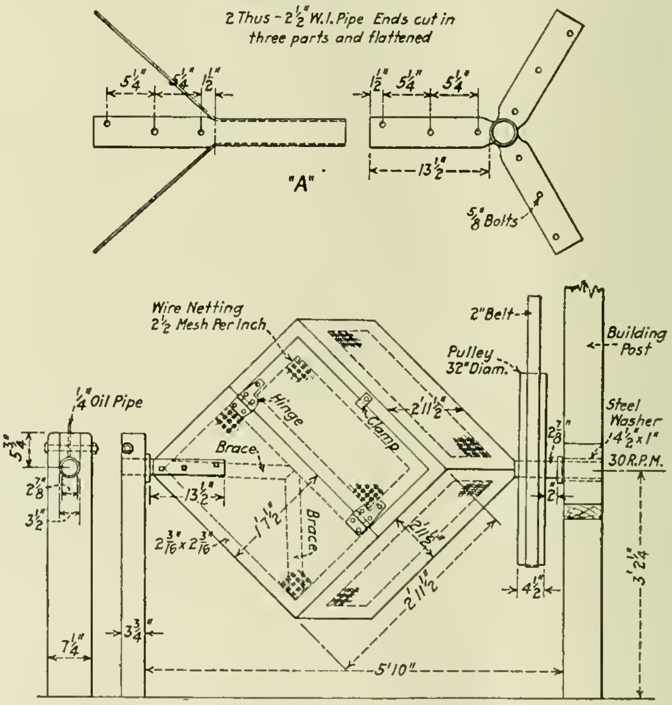
The preceding discussion pointing out the more important considerations involved in a study of the economic value of various types of motive power demonstrates the complexity of the problem. Probably no absolutely correct analysis is possible; surely, it is not practicable. The question is of extreme importance because the possibilities of economical operation are circumscribed by the motive power. For that reason the choice of the locomotive should be made with extreme care. The final decision should be based on a definite knowledge of the economies that can be realized, not on unsupported opinion. Engineering methods are essential in working out the solution and the study of the problem offers a field for constructive co-operative work by the members of the engineering societies.

Sifter for Renovating Old Sponging Waste

BY NORMAN MacCLEOD

In the reclamation of dirty sponging waste the device illustrated can be used effectively for sifting out dirt, sand, etc. The sifter consists of a wooden framework, made of 2 3/16 in. material, 2 ft. 11½ in. on each side. The sides are covered with smoke box netting, 2½ meshes to the inch, one side being provided with a hinged door for inserting and removing the waste. A small clamp, when swiveled in place, prevents the door from opening.

To the whole sifter are attached trunnions or bearings which are placed on diagonal corners on the outside. These trunnions, as shown at *A* in the illustration, are preferably made of 2½ in. W. I. pipe, with the ends split and flattened, being bolted to the framework with ⅝ in. bolts.



Device for Sifting Dirt Out of Old Sponging Waste

The device is mounted with one bearing in the side wall of the building, and the other in an outboard support. A 4½ in. by 32 in. diameter pulley, driven by a motor or convenient pulley from a nearby main shaft, is arranged to turn the sifter at about 30 rev. per minute. This device is extremely useful as a part of waste reclamation equipment.

Car Shops Are Carefully Planned in Advance; Why Not Schedule Car Repair Work?

Scheduling Car Repairs Increases Shop Output

Outline of a Schedule Applicable to Passenger or Freight Car Repair Work in Large or Small Shops

By E. T. SPIDY*

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THE reason passenger and freight car repair schedules have received so little attention in the past is rather hard to understand. It may be because a large percentage of rolling stock superintendents are motive power men, having a more intimate knowledge of the details of locomotive repair work. In any case, scheduling locomotive repairs is now a recognized, economical method of keeping operations and parts moving, with the result that locomotives are held "out of service for repairs" a minimum length of time. For the past ten years, at least, it may be said that most large back shops have had a schedule or routing system of some kind in use, which definitely set up a plan whereby equipment was to be delivered repaired in 9, 12, 18 or 25 days, if necessary, according to the amount of work to be done. In every case, a definite delivery date was established and each day's work planned so as to complete the whole on the specified or scheduled date.

There is no logical reason why passenger and freight equipment cannot be scheduled so as to produce more output for these departments, as has been accomplished for the locomotive department. The same principles apply. Each shop, to have a successful schedule, must get a clear idea of what the objective is and how it is to be attained, taking into account the condition peculiar to each shop. The first thing a car man will say when the schedule is mentioned is "That's all right in the locomotive side where locomotives only are handled, but over here, we have twenty different kinds of cars, baggage, mail, day coaches, sleepers and so on, and we never know what must be done to them until they are brought in." In reality locomotive department men do not know exactly what must be done to engines before they are stripped, but depend upon careful inspections to determine the class of repairs needed. It is not the *amount of work* to be done that counts in determination of output; it is the time required to perform the *longest job.*

Description of Schedule for Steel Diner

The first step in building up of a passenger car schedule, for example, is to plan or lay out the work to be completed each day. Assume that a schedule is to be made out for a steel dining car, shown by examination to be in pretty bad shape with considerable carpenter work inside and paint in bad condition, needing complete removal. This means that all trimmings will have to be taken out and done over and everything else given general repairs. In proceeding to make up the schedule let us assume the following conversation with the general foreman (G. F.) and paint shop foreman (P. F.):

"What is the longest job on this car?"

P. F. "Painting operations of course."

"Inside or outside of car?"

P. F. "Outside, in this case; sometimes, however, the inside is the biggest job."

"Yes, but does the inside painting govern the length of time the car is in the shop?"

P. F. "Not usually, because when the outside is finished, the car can be pulled out of the shop and the inside finished there if necessary."

"All right. Now, since the painters have the longest set of operations, let us get them on the job as quickly as possible, and see if we cannot do all the other work inside the time required by the painters to complete their work. What do you do first?"

G. F. "Remove all metal trimmings, seats and sashes, and send them to their respective departments to be repaired. Then the car is washed."

"Could not this stripping be done before the car is taken into the shop? And how long should it take?"

G. F. "Yes, no trouble about that, especially in good weather. In any case, including the washing, one day would cover this work."

"In preparing the standard schedule sheet (Fig. 1) the

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car is stripped complete and washed the first day. Also on the first day in the shop, the electricians must be on the job and strip their part, all other material being removed from the inside and distributed to the proper departments for repairs. The washing department must wash the car so as to be ready for the next day's operations. What part of the work is done next?"

G. F. "The car is moved to the track where it will stay until turned out. Carpenters go on the job. The car is jacked up, trucks removed and the car lowered on shop trucks or posts."

"Let us put all that down for Day 2, but there is no reason why painters cannot also start to remove paint, is there?"

P. F. "I guess not. Put them down to start, and they will finish the next day."

"When will the carpenters complete their work so that the painters can go ahead?"

G. F. "That will depend upon conditions, but I should say they would want two days on the outside and four on the inside."

"Let us put it down at that and you can increase the gang if necessary, to get it done on time until they get into the stride of the thing. Notice that the carpenters start outside work on Day 2, finishing on Day 4 and inside carpenter work is started on Day 2, being finished on Day 6. This means that painters on the outside start on Day 2 also, but painters on the inside cannot do much until the carpenters are clear. They may start in places, but we will not schedule them started because, for a good job, the carpenters must be out of the way. Now let us list up paint operations and the time required."

G. F. "We do not have a regular course for all cars, although generally we do go through a process which is modified according to the output desired."

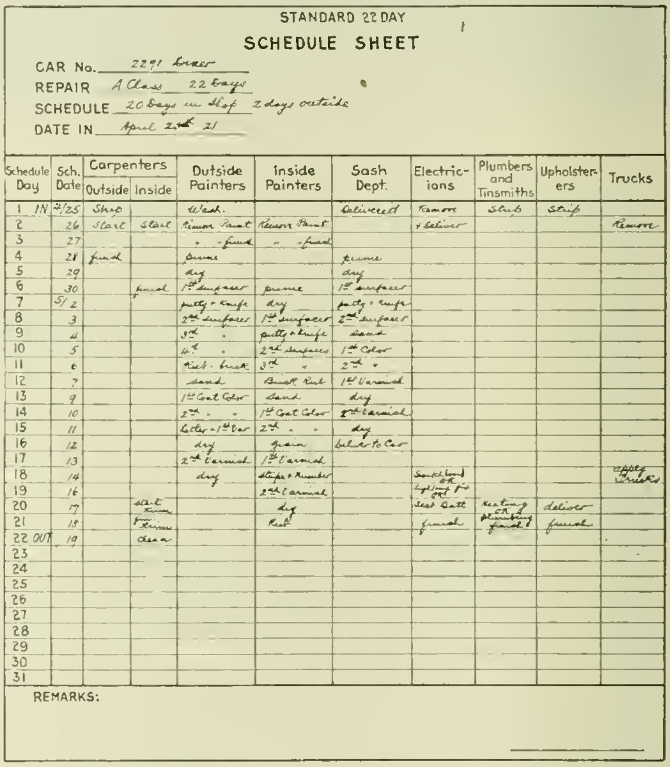
"Too bad, but not unusual by any means. It follows obviously that without uniformity of treatment, uniformity of results cannot be expected, and so nobody knows whether good or bad service is the result of poor materials, methods or work. The American Railway Association Committee on Equipment Painting issued a report in 1920 giving a recommended classification for painting car department equipment, which we might adopt in this discussion as a base on which to work. Let us use it for a start, and build up a schedule, changing it if necessary. The car evidently comes under the first paint schedule given, Class A repairs being the heaviest repairs shown. It is evident that Day 1 for the painters is Day 2 in the shop on our schedule. Operations on the schedule follow."

Day 2. Carpenters start on outside and inside.
Trucks removed and delivered to truck repairers.
Painters start to remove old paint and varnish.
Day 3. Painters finish removing paint on outside.
Day 4. Carpenters on outside finish.
Painters put on priming coat.
Day 5. Inside carpenters still on inside work.
No paint operations, as primer requires 48 hours to dry.
Day 6. Inside carpenters finish.
Apply prime coat on inside of car.
Apply first coat of surfacer on outside.
Day 7. No paint operations on inside, account 48 hours being required for primer to dry.
Day 8. Outside—second coat of surfacer.
Inside—first coat of surfacer.
Day 9. Outside—third coat of surfacer.
Inside—putty and knife pitted surfaces.
Day 10. Outside—fourth coat of surfacer.
Inside—second coat of surfacer.
Day 11. Outside—rub with rubbing brick and water.
Inside—third coat of surfacer.
Day 12. Outside—sand and torch up with primer.
Inside—Rub with rubbing brick and water.
Day 13. Outside—first coat of color.
Inside—sand and touch up with primer.
Day 14. Outside—second coat of color.
Inside—first coat of color.
Day 15. Outside—letter and apply first coat of varnish.
Inside—second coat of color.
Day 16. Dry day, no operation on outside.
Inside—grain.
Day 17. Outside—second coat of varnish.
Inside—varnish (first coat).
Day 18. Outside—dry day, painters on outside finished.
Inside—stripe, number and necessary notices applied.

Before proceeding, we note here that since the outside work is all finished, as far as the painters are concerned, there is no reason, if shop track space is a limiting factor in getting output, why the car could not be trucked with the repaired trucks on the eighteenth day. Day 18, therefore, constitutes the date for the truck repair gang to finish and deliver ready for the car, its own trucks. If necessary, the car can be finished outside of the shop from Day 18. Proceeding with the painters inside the car:

Day 19. Varnish inside of car (second coat).
Day 20. No operation, allowing varnish to dry.
Day 21. Rub varnish to finish required.

With the painters finished, the work of other departments should be considered, to be sure that they will deliver parts in sufficient time to apply completely without holding up the car. Car trimmers cannot start until inside painters have finished varnishing operations at least, and the work takes possibly two days. So we add to the list:



STANDARD 22 DAY

SCHEDULE SHEET

CAR No. 2291 Diner
REPAIR A Class 22 Days
SCHEDULE 20 Days in Shop 2 days outside
DATE IN April 24th 21

Schedule Day	Sch. Date	Carpenters		Outside Painters	Inside Painters	Sash Dept.	Electricians	Plumbers and Tinsmiths	Upholsterers	Trucks
		Outside	Inside							
1 IN	4/25	Shop		Wash.		Delivered	Remove	Strip	Strip	
2	26	Start	Start	Remove Paint	Remove Paint		+ deliver			Remove
3	27			" -finish	" -finish					
4	28	finish		prime		prime				
5	29			dry		dry				
6	30		finish	1st surfacer	prime	1st surfacer				
7	5/2			putty + knife	dry	putty + knife				
8	3			2nd surfacer	1st surfacer	2nd surfacer				
9	4			3rd "	putty + knife	sand				
10	5			4th "	2nd surfacer	1st Color				
11	6			Rub - brick	3rd "	2nd "				
12	7			sand	Brick Rub	1st Varnish				
13	9			1st Coat Color	sand	dry				
14	10			2nd " "	1st Coat Color	2nd Varnish				
15	11			letter + 1st Var	2nd " "	dry				
16	12			dry	grain	deliver to Car				
17	13			2nd Varnish	1st Varnish					
18	14			dry	stripe + number		Switchboard OK			apply trucks
19	16				2nd Varnish		Lighting fix OK			
20	17		start trim		dry		Seat Batt	heating OK &	deliver	
21	18		finish trim		Rub		finish	plumbing finish	finish	
22 OUT	19		clean							
23										
24										
25										
26										
27										
28										
29										
30										
31										

REMARKS:

Fig. 1—Example of Standard Schedule Sheet for Dining Car

Day 19. Trucks applied.
Day 20. Car trimmings finished and delivered to car, and trimming started.
Day 21. Finish trimming car.
Day 22. Clean, inspect and O. K. for service.

The longest operations on the car are now covered. They might be called the controlling operations of the schedule since they control the length of the "out of service" period. In order to make this schedule complete, it is necessary to set a starting day and a finishing day for all sub-departments that handle any part of the car. Thus, electricians must finish all testing the same day the trimming is finished; namely, Day 21. Plumbers, steamfitters, upholsterers, etc., must also finish on Day 21. For each of these departments, it may be advisable to detail each day's work so that, even if they have only six days' work to do, and a period of twelve days in which to do it, the minimum number of men required may be determined. In larger shops, there is a sash department to which all sash are delivered when a car is stripped. This department usually gives sash practically as long a schedule of operations as the outside of the car gets. All departments are capable of a detailed analysis as outlined, but it is not always advisable to go into such details for the sub-departments, depending entirely on the amount of work handled per month.

The net result of the foregoing is to develop what may be called a twenty-two day schedule for this class of car and repair. What logical reason is there why a similar schedule for each class of repairs cannot be developed? Heavy, medium and light repairs, called Class A, B and C according to A.R.A. recommendations, are decided on. Equipment is divided into as few "class of car" divisions as practicable. All passenger equipment, for example, coming in one general class which may be subdivided into ordinary day coaches, sleepers, diners and other high grade equipment. Next baggage and mail cars may form a class and so on according to the requirements of a particular road.

Operation of the Schedule

Having made this schedule, how is it to be handled? First of all, using a calendar, mark opposite Day 1 on the schedule the date that corresponds to the day the car is booked in. Then follow down the schedule, inserting a date opposite each day, Sundays and holidays being omitted, but not Saturdays. Even if only half a day is worked on Saturday, try and arrange for a coat of paint to be applied, because Sunday then becomes a schedule day, if it can be utilized for drying.

Next take a large sheet of section paper about 24 in. square and makes a series of about 30 vertical columns as shown in Fig. 2. At the head of each column put in the dates of the month, leaving out dates corresponding to Sundays and holidays. On the left side of the sheet, list up all the operations which have developed and leave room for others that may come up. Now take the schedule list with the dates entered and, starting at the top, find the corresponding operation on the large sheet, entering the car number on the same horizontal line under the required date. Follow this process by putting this same car number in the intersecting square of each operation and date it is scheduled to be performed and you have a complete "date schedule." It is advisable to mount the date schedule on a board.

DATE SCHEDULE

NAME OF OPERATIONS		APRIL						MAY																							
		25	26	27	28	29	30	2	3	4	5	6	7	9	10	11	12	13	14	16	17	18	19	20	21	23	24	25	26	27	28
Car in Shop		2291																													
Trimming removed		2291																													
Car Washed		2291																													
Carpenters start	Outside		2291																												
" "	Inside		2291																												
Trucks removed			2291																												
Painters start to remove paint	Out & In.		2291																												
Painters fin. remove paint	Outside			2291																											
Carpenters finish	Outside				2291																										
Painters apply priming coat	Outside				2291																										
Drying day for primer	Outside					2291																									
Carpenters finish	Inside						2291																								
Painters apply prime coat	Inside						2291																								
" " 1st coat surfacer	Outside						2291																								
Drying day on inside								2291																							
Second coat surfacer	Outside								2291																						
First " "	Inside								2291																						
Third " "	Outside									2291																					
Putty and knife	Inside									2291																					
Fourth coat surfacer	Outside										2291																				
Second " "	Inside										2291																				
Rub with brick and water	Outside											2291																			
Third coat surfacer	Inside											2291																			
Sand and touch up	Outside												2291																		
Rub with brick and water	Inside												2291																		
First Coat of color	Outside													2291																	
Sand and touch up	Inside													2291																	
Second coat of color	Outside														2291																
First " "	Inside														2291																
Letter and apply 1st coat varnish	Outside															2291															
Second coat color	Inside															2291															
Drying day for varnish	Outside																2291														
Grain	Inside																2291														
Second coat varnish	Outside																	2291													
First coat varnish	Inside																	2291													
Drying day for varnish	Outside																		2291												
Apply trucks (if to finish outside)																			2291												
Stripe and number	Inside																		2291												
Second coat varnish	Inside																			2291											
Apply trucks and level car	(if in shop)																			2291											
Drying day for varnish	Inside																				2291										
Trimmings, start to apply																					2291										
Rub down varnish	Inside																					2291									
Finish trim car																						2291									
Plumbers finish																						2291									
Steamfitters finish																						2291									
Upholsterers finish																						2291									
Electricians test and finish																						2291									
Clean and O.K for service																							2291								

Fig. 2—Schedule for a Single Car Showing Dates Detailed Operations Are Due

As each car comes into the yard, an inspection of the car and painting is made to determine the class of repairs. A detailed schedule is then prepared covering all operations, this being done by the man placed in charge of all scheduling.

PASSENGER DEPARTMENT SCHEDULE

April 4.

Daily Work Sheet

The following operations are due to be completed tomorrow, April 5:

Car No.	Outside	Inside
334	Remove paint	Remove paint
2123	Prime	
2099	First surfacer	Prime
654	Putty and knife	Dry
743	Scrape	Scrape
1435	Dry	Second varnish
763	Third surfacer	Putty
871	Letter	First varnish
1235	First color	Sand
1743	First varnish	Second color
884	Sand	Third surfacer
2377	Second varnish	First varnish
671	Dry	Rub
943	Rub with brick	Third surfacer
1066	First varnish	Dry
1132	Dry	Grain

Fig. 3—Work Sheets Are Taken Daily from the Date Schedule and Sent to Departments Concerned

Each detail sheet is entered on the date schedule as soon as made out, and when all cars in the shop are covered, each column represents the operations due to be performed on the date at the top of the column.

Now comes a most important point. This chart, like all charts, is of little value unless used. Each afternoon, the schedule man makes a list of all work due to be done tomorrow. He gets this list typed out and into the hands of all foremen and assistant foremen concerned before they quit for the day. In the afternoon, he goes to each car and checks up to see if the operations scheduled are done or not; if not, he ascertains *why* (again an important point) and marks his copy with the reason. On returning to the office, he makes a list of all failures to do the work scheduled, indicating the reasons, and hands this list to the general foreman. The general foreman then goes to all departments knowing where they were delayed the previous day and lending his influence and authority to prevent a recurrence of delays in the future.

It soon works out that when an assistant sees he is going to fail, he takes up the matter himself before the general foreman gets after him about it and very often the delay is prevented altogether. If average outputs before and after car shop schedules are in operation are checked, nobody will have an argument against the schedule. The great probability is that under schedule planning, output will increase 30 per cent and more and the railroad will have a definite measure of the service given by the materials used.

The whole idea is to have a definite plan and see that it is lived up to. The car schedule, illustrated, was for the heaviest kind of repair on the class of car that gets the best work done on it; therefore, it is probably the longest schedule likely to be used. The example taken was merely to show how to build up schedules, not to say this is a correct or good one for any particular shop.

PASSENGER DEPARTMENT SCHEDULE

April 4.

DAILY WORK SHEET

The following operations are scheduled to be done tomorrow, April 5:

Department	Car No.	Operation
Carpenters	334	Start outside
	2123	Finish outside
	2099	Finish inside
	654	Finish inside. Late one day
	743	Start outside
Upholsterers	2541	Deliver to car
	2632	Deliver to car
	4122	Deliver to car
Steamfitters	2541	Finish heating
	2740	Finish heating
Trimmers	2541	Finish trim
	1435	Start trim
Electricians	2541	Batteries test and lighting O. K.
	1435	Switchboard O. K.
Brass Dept	1734	Deliver all trimmings
	1438	Deliver all trimmings

Fig. 4—Example of Daily Work Sheet

Figuring Monthly Output

A word or two regarding figuring output per month by schedule methods. If a shop has 60 tracks or car spaces under the roof and the number of schedule or working days in a month is 25, the product of these two factors is 1,500 track days. Now suppose, on an average, a heavy repair takes 20 days; a medium repair takes 12 days, and a light repair takes 8 days. We can readily see that including all schedule days under the shop roof an output of 75 heavy repairs, or 125 medium repairs, or 185 light repairs is available. Also if it is decided to finish cars outside of the shop, that is take them from under the shop roof as soon as outside painting operations are finished, the shop capacity is automatically increased by deducting at least two days per car under the shop roof. This means that the output can be increased to 83, 150 and 250 cars per month for heavy, medium and light repairs respectively, an average increase of over 25 per cent by a decrease of only two days per car. Is it important?

PASSENGER DEPARTMENT SCHEDULE

WEEKLY PROGRESS SHEET

To all Departments:

The following cars are due for service next week on dates shown:

April 4—Monday	1322	April 7—Thursday	975
	763		1747
April 5—Tuesday	1421		717
	1530	April 8—Friday	1414
	621		1175
April 6—Wednesday	1483		918
	1377	April 9—Saturday	1749
			606

Fig. 5—Weekly Progress Sheet for the General Information of All Supervisors

No road gets all one kind of repairs, so by using the total track days available as a base and multiplying and adding cars of each class of repairs (heavy, medium and light) as they may be available, keeping the sum equal to 1,500, the maximum output under definite methods is obtained. Suppose an output of 130 cars a month in this particular shop is desired.

50 heavy repairs at 18 days each........ = 900 track days.
30 medium repairs at 10 days each....... = 300 track days.
50 light repairs at 6 days each.......... = 300 track days.

Total available .... = 1,500 track days.

Any other combination that adds up to 1,500 track days on 20, 12 and 8 day schedules, figuring to finish the last two days' work outside, can be used.

In conclusion, it may be said that the foregoing outlined schedule is applicable to small shops as well as large ones. The main difficulty in applying it is due to the aversion of many practical railroad men, brought about unfortunately by an influx some years ago of so-called efficiency engineers without practical knowledge of railroad conditions. The schedule gives a clear definition of duties and definite instructions as to the order of work, resulting in better service at lower costs. In shops where material is scheduled from one department to the other foremen can stay in their own departments, where they are needed all the time. This is one of the biggest arguments for scheduling, and alone is worth more than can be estimated. The details of forms and methods will develop themselves in each shop and constitute no valid objection to car shop scheduling systems.

PASSENGER DEPARTMENT SCHEDULE

LATE LIST APRIL 7

The following delays were reported yesterday:

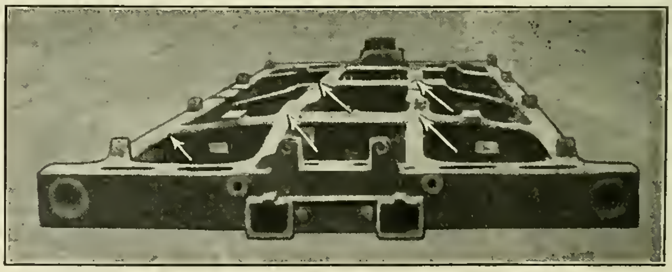
Car No.	Department.	Reason for delay
1717	Paint	Men out
1643	Paint	Carpenters not finished
2321	Carpenter	Waiting material from mill.
763	Electrician	Battery trouble
1431 (2 days)	Truck	Waiting for tires

Fig. 6—Summary of the Delays Occurring in One Day, Material Delays Also Being Recorded on This Form

Reclamation of a Badly Distorted Tender Frame

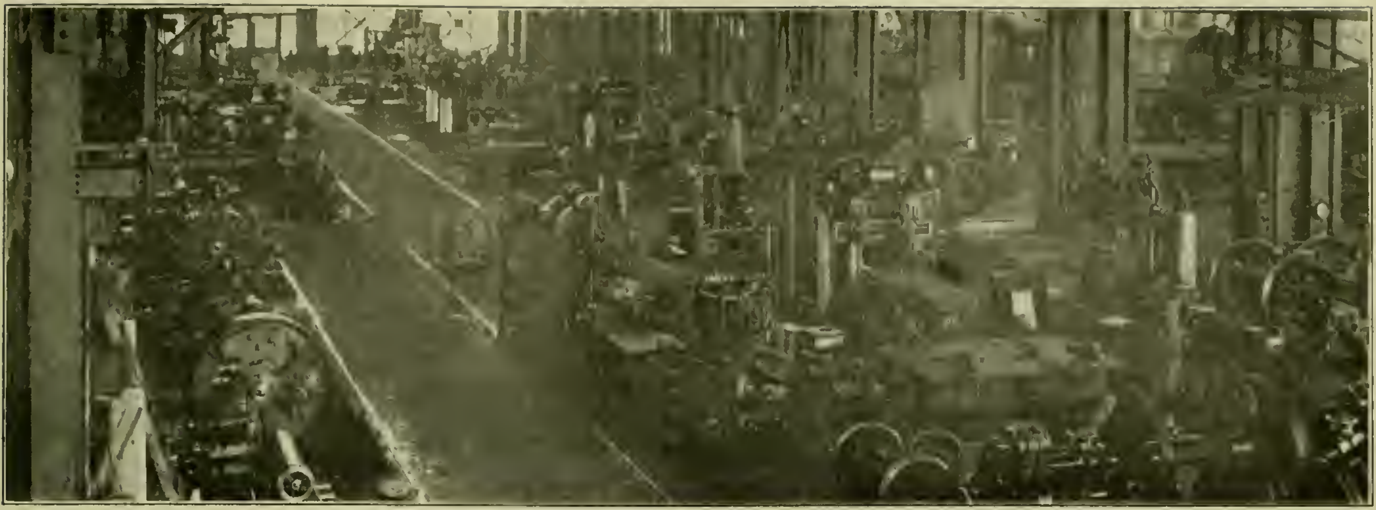
A locomotive recently came to a back shop for repairs with the tender frame badly damaged and distorted by a side blow. In view of the serious nature of the damage it was at first thought that the frame would have to be scrapped but it was finally reclaimed by straightening and welding.

Before proceeding with the straightening, a special straight lever was made by using two bars of 2¼ in. by 9 in. by 18 ft. follower plate steel. A space of 3 in. was left between the bars for eyebolts and clamps, an arrangement which gave a powerful leverage. It was necessary to heat the tender frame in eight places at one time in order to straighten each end of the frame.



Tender Frame Straightened and Thermit Welded at Five Places

Oil and charcoal were used as fuel in obtaining the expansion. The center I-sections that were broken were welded in five places with Thermit using about 65 lb. for each weld. The location of these welds are plainly shown in the illustration by the arrows.



The Problem of Machine Tool Selection

Ignorance of Cost of Capital Investment and of Operating Costs Leads to Unsound Decisions

BY R. S. MENNIE

THE usual procedure for the purchase of shop machinery, after the annual budget has been approved, is somewhat similar on the various leading railroads. The first step is to prepare a list of machines, the extent of which will depend entirely upon funds available or the amount appropriated under the budget. Requisitions are then originated either in the office of the chief mechanical officer or at the shops where the machines are finally to be located. After requisitions have been prepared, including more or less complete specifications, they are forwarded to the purchasing agent who obtains bids from various manufacturers or jobbers and submits these bids with the manufacturer's standard specifications to the chief mechanical officer for final recommendations.

In view of present conditions as regards the urgent necessity for strict economy, it may be of interest to discuss the consecutive steps in the purchase of this equipment. First, the preparation of the initial machine tool list for the annual budget. This is usually done by master mechanics or some mechanical department officer in close touch with the shops. Frequently, the local shop authorities make a list of their machine tool requirements and forward this to the general office, where the budget recommendations are eventually compiled. In any event the final list of machinery usually expresses as far as available funds will permit, the ideas of the shop officers as to their machine tool necessities.

Capital Charges Often Disregarded

It should be remembered, however, that under existing methods of shop accounting, these ideas are not regulated or controlled by any thoughts as to the possibility of incurring heavy additional capital charges or similar considerations which usually govern the management of manufacturing establishments in like circumstances. There is always the possible tendency to insist upon new machinery and the replacement of old tools without the formality of any careful analysis to determine whether or not a new machine is really necessary or whether the expense is justified by the possible savings.

Compare the attitude of a railroad master mechanic with that of the manager of any successful manufacturing plant. The master mechanic endeavors to get rid of all old machinery and to substitute modern, up-to-date equipment. He is well aware that with high grade tools in good condition, locomotive repair parts can be rapidly handled through the shop and there is an excellent possibility that output will increase to the assumed benefit of the company and his own certain credit. He has no incentive to go very deeply into the economics of the matter nor to consider that the additional production obtained through the purchase of new machinery may not necessarily mean a net profit to the railroad.

On the other hand, the manager of an industrial concern must analyze the situation with great care, because he is constantly confronted with the fact that the purchase of additional machinery means an increase in fixed charges. He knows that if this additional capital charge is not met by increased savings, by a reduction in the number of employees, or absorbed in some way, the cost accounting system will shortly indicate a loss instead of the anticipated profit.

Unfortunately the cost accounting methods used in the average American railroad shop do not reflect the true situation as regards the ultimate expense to manufacture and apply locomotive or car repair parts. It is, therefore, only to be expected that advantage will be taken of this fact to secure credit for increased shop output regardless of heavy losses in depreciation, interest, maintenance, etc., that are never accurately set forth.

Specifications for Machine Tools

The preparation of machinery, specifications and shop requisitions is a second step in the purchasing procedure. Assuming that the machine tool list has been properly compiled after a careful study of the matter in all phases, it is then of equal importance that machines of proper size and design shall be specified.

For the ordinary railroad shop engaged in making general locomotive repairs, a few special tools such as wheel lathes, quartering machines, wheel presses, etc., are required. By far the greater number of machines, however, are standard equipment widely manufactured, such as boring mills, lathes, planers, shapers, drill presses, etc. It does not seem advisable for any railroad to attempt the preparation of complete specifications covering exact details of their machine tool requirements, as this results in high prices without commensurate benefits. The plan usually adopted is to prepare a brief statement giving merely the essentials of the tool desired including kind of drive and necessary special attachments. This permits manufacturers to submit bids on their standard product and enables the railroads to obtain wide competition.

Size of Tools Needs Careful Study

In preparing requisitions for shop machinery it is important to keep in mind the various operations for which the tools will be used and in particular, if machines are to be located at some isolated point, to see that each tool has adequate capacity to handle the occasional big job which otherwise would have to be sent perhaps two or three hundred miles to some place having the required facilities. It is a matter of considerable annoyance and often quite costly to find, after installing an expensive new machine, that one-half inch greater swing or another foot added to the bed would have enabled the isolated shop to take care of the extended piston rod or some other exceptional part and avoid holding a badly needed locomotive out of service perhaps days or even weeks.

For the larger shops where a variety of lathes, planers, drill presses, etc., must be provided, there is a possibility that machines larger than really necessary will be specified. Long lathe beds, planer beds, etc., take up much valuable space. Exceptionally long work should, of course, be provided for, but when this is done the remaining machines ought to be specified in accordance with the work they are intended to perform. In some shops as many as six or eight 30-in. and 36-in. lathes each with 16-ft. beds may be observed. On the majority of these machines the work is such that about six feet of the bed is never used and serves principally as a handy receptacle for waste, surplus tools and miscellaneous litter.

Special Attachments

It is important in preparing requisitions or specifications for shop machinery to keep in mind the fact that it is often desirable to have machines equipped with special attachments or devices that will enable the handling of work never contemplated by the tool manufacturers. I have in mind one case where a 100-in. boring mill was equipped with a special fine feed attachment thereby enabling packing rings to be cut in emergencies when the smaller mills ordinarily used for this purpose were crowded with other work. No doubt very many similar instances can be called to mind where new machines have been altered or provided with special home-made appliances which might easily have been taken care of during manufacture and at much less expense if the specifications had been drawn sufficiently complete to include these items.

It is also advisable in preparing specifications for machinery to make some mention of the necessity for the thorough safeguarding of all dangerous moving parts. Most manufacturers of metal working machines include these guards as part of their standard design, but in the case of some woodworking machinery guards are extra and are not furnished unless definitely specified. Money can usually be saved if this equipment is provided by the builder and the guards are frequently of neater design than those applied by shopmen after the machines are installed.

Selection Should Be Based on Study of Details of Construction

When bids have been secured the next step, prior to placing orders, consists in selecting the most suitable equipment from the quotations received. This is usually done by a mechanical department officer or by an official committee. In any event, it is of vital importance that the recommendations made to the purchasing department covering the final choice of machine tools, shall be based upon a sound knowledge of value, unbiased by prejudice or the persuasive conversation of expert salesmen. Perhaps the greatest obstacle to overcome in judging machine tool values is prejudice on the part of sometimes thoroughly practical men. Prejudice in favor of a manufacturer's machine with which railroad men are familiar, often works to the serious disadvantage of some other manufacturer having a better tool the superior quality of which only becomes apparent after a study of its intimate construction. The average mechanical department officer has practically no time to study closely the construction of machine tools—he has many more serious problems to contend with—consequently his tendency is to be conservative. The result is often to favor the familiar machine, one that has proved satisfactory in the past, although it may not by any means be the best machine and may even be seriously deficient, if judged by modern standards.

In order to keep the shop machinery of a railroad with average traffic up to a reasonable standard of efficiency, the writer estimates that it is necessary to spend about $20,000 per year per 1,000 miles of line. Based on this estimate a 6,000 mile railroad should spend $120,000 per year on new shop machinery. This amount does not include maintenance or repairs, but merely replacements and additional equipment. Consequently, after a railroad system attains a size of more than about 2,500 miles, the annual sum expended for shop machinery begins to assume an importance well worthy of someone's time to make certain that there shall be no waste of company funds.

Avoid Unnecessary Refinement

In selecting railroad shop machinery from quotations and accompanying specifications, it is well to remember that in many cases an ordinary, moderate priced lathe, planer or other machine is the best possible choice. For example, at some outlying point at irregular intervals a planer or boring mill is badly needed. This machine will be used perhaps two or three times per day. In this case, the usual policy is to transfer an old machine from one of the larger shops, but if it is decided to install a new machine, a low priced tool of simple construction or a second-hand machine in good condition, should be selected.

Even for the important shops, if the work to be handled in each instance is given consideration, it will often be found that a machine of moderate price will meet requirements. Railroad machinists do not usually work with micrometers or with limit gages. The situation is very different from that in those manufacturing establishments where success is entirely dependent upon ability to produce rapidly interchangeable parts accurate to the 1/10,000 part of an inch. The best and most refined construction in machine tools is none too good for this purpose, whereas in a railroad shop, machines of this type are a questionable investment.

Machine tool dealers when requested to bid on railroad specifications usually quote on their high grade product with an alternative bid on some less well known tool of considerably lower price. Most of us have a natural tendency to favor the high priced article, especially if the necessary finances are available. It is well, however, to bear in mind that for railroad shop service the alternative and lower bid is frequently by far the better proposition.

I do not desire to convey the impression that machines of inferior or cheap construction should be considered. Tools of this character are very high priced and eventually prove to be the worst possible investment. The machines in mind are rigid, well built tools with adequate bearing surfaces, steel gears where necessary, good lubrication facilities and all essentials of a first class product. They have not perhaps that exact refinement and high accuracy best adapted for interchangeable manufacturing operations. Such operations, however, are of a precision entirely foreign to those usually performed in a railroad shop.

Success in the selection of suitable machinery for railroad service can only be attained by a constant study of shop operations and the exercise of sound judgment in providing adequate facilities to handle these operations with neither the wasteful expense involved in over-refined and elaborate equipment nor the even greater extravagance incurred by choosing cheap, poorly constructed tools.

Analyze Cost of Shop Operations

Some kind of a real cost accounting system, if a practical scheme could be devised for railroad shops, would undoubtedly be of great benefit in the economical selection of machine tools. No shop superintendent or master mechanic would then insist upon expensive shop equipment if he knew that from 20 to 25 per cent of each dollar invested in such equipment would be added annually to the cost of work done under his jurisdiction. He would at least have the incentive to analyze carefully the necessity for new machinery and to ponder seriously the advisability of such recommendations as a $6,000 motor-driven, geared head lathe when a three step cone belt-driven tool at $4,000 would meet requirements.

In the absence of such a system the best that can be done is to impress all concerned with the fact that unless a machine can be kept constantly busy producing a steady output, loss is incurred depending upon the length of time the tool is idle and the total amount of money invested. Therefore, when it is known that a machine must necessarily be idle a considerable portion of the time, it is wise to keep the investment at the lowest point possible by the use of an old machine or purchase of second-hand equipment. In any event, when a new tool is contemplated a careful statement should be made estimating as closely as possible the cost to handle each unit of production with the existing equipment. A similar statement should then be prepared to determine the cost with the new installation. If this work is done properly it will be possible to arrive at some definite idea as to the savings that may be expected when the proposed new installation is complete. In both estimates care should be taken to include capital charges both upon the old and new investments.

Analyses of this character are of the utmost value in determining whether or not it is wise to make expenditures for machinery and if prepared in a true businesslike manner they will be of great assistance in demonstrating to the management just how much can be saved and exactly to what extent new machinery is justified.

Improving a Shop by a Limited Expenditure

A Small Production Department Relieves the Machine Shop and Insures Maximum Output from New Tools

BY G. M. LAWRENCE

THERE is little chance for argument about the necessity for improved shop machinery. Now that the Labor Board has abolished the National Agreements and laid down a set of rules which give promise of paving the way for industrial peace through local conference and agreement, it is the hope of all shop supervisors that more consideration will be given the problem of shop equipment.


Main Rod Brasses, Machined in Shop Order Lots of 30 Pairs

However natural it is to blame all our troubles on the war and the result of federal control, most shop men know that the present lack of efficiency is partly the result of neglect in keeping abreast of the times with needed improvements in the shop to properly maintain the ever changing locomotive. For many years, while inventive genius has enlarged and improved the locomotive from a 40 to 60-ton machine to the present magnificent power plant, the shop and terminal facilities for handling the locomotive on a large number of railroads have practically stood still, leaving the inventive mechanic to work out the problem of maintenance with equipment 40 years old. Of course some enlargement of terminals, turntables, coaling facilities, etc., has been made as a result of necessity and electric and oxy-acetylene welding and cutting have been introduced in most shops, but in too many shop the progress has stopped here. In no department is the neglect more apparent than in the machine shop.

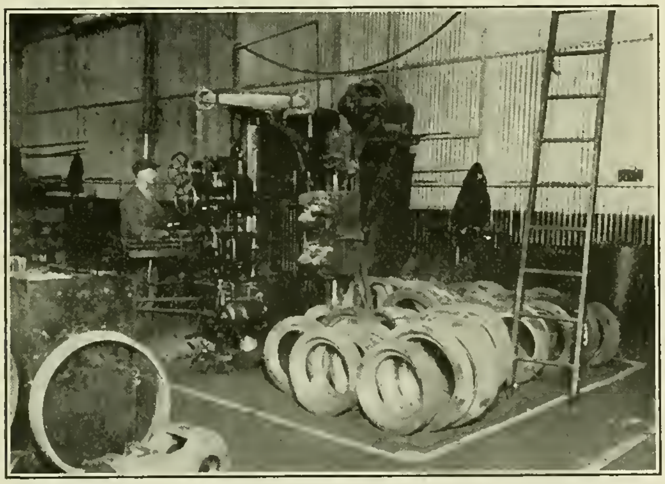
To correct these conditions at once would mean an entire new shop in a great many cases at a cost of several hundred thousand dollars and there are no such sums available at present nor are they likely to be for some time to come.

The machine problem at least can be partially solved, I believe, by the introduction of a production department. A modest beginning can be made by the purchase of six machines as follows: a 42 in. vertical turret lathe, a 6 ft. radial drill press, a 10 ft. planer, a 28 in. heavy duty shaper, a 24 in. slotter and a 3 in. turret lathe. This equipment can be purchased at a cost of not to exceed $30,000.

These machines should be installed in a room or building apart from the regular machine shop and under the supervision of a foreman responsible only to the general foreman. In the contract for these machines should be included the services of a demonstrator whose duty would be to instruct the workmen in producing maximum output from each unit. By the proper use of these machines it would be possible to finish all the cylinder heads, crossheads, driving and truck boxes, brasses and cellars, valve bushings, bull rings and packing rings, cylinder packing rings, piston heads, eccentrics and straps, air pump cylinder bushings, guides, shoes and wedges, rod straps, frame and pedestal braces, brake and spring rigging pins and bushings, cylinder head and boiler studs and many other parts too numerous to mention in sufficient quantities to supply a shop output of 25 engines per month. All parts should be manufactured in quantities of not less than a day's output per machine at a time, wherever possible, as modern machines are designed primarily for production work and efficiency is lost by making frequent changes in setup. A record should be made of all operations in their relative sequence, giving tooling, etc., as well as the minimum time required for each operation as a guide to the workman and a measure of efficiency. All tools should be prepared in the tool room and only minor grinding to restore the cutting edge should be permitted at or near the machine to keep the machine producing as much of the time as possible.

When these machines have been in service a short time it will be possible to take many of the older machines out of service, a few at a time, for a much needed overhauling. A few of the very best mechanics should be assigned to this work and a thorough job done which will restore the efficiency of the machines and put them in condition to permit better workmanship.

The introduction of a cost accounting system into the shop would reveal many sources of economy and would result in a great many changes in practice. No merchant or manufacturer could be successful in business who did not know in detail the cost of his product for the reason that he would not know what to charge the consumer. The total cost of transportation is doubtless known, but who in the shop can truthfully state for instance whether it is more profitable to manufacture square-head bolts in the shop today than to purchase them in the open market or whether it is more profitable to file saws by hand or invest a few dollars and purchase an automatic machine that will file ten times more saws than a man and produce a vastly more serviceable tool as well? Cost accounting and production should go hand in hand in the railroad shop. Before a new tool is purchased it should be known absolutely that the investment is going to be profitable. Labor and material costs are constantly changing and therefore an operation which is profitable today may represent a loss tomorrow. With the present high cost of labor it would doubtless be more profitable to purchase a new machine here and there about the shop to do work now done by hand. For example, it is customary in most shops to flange all sheets used in boiler work by hand, by the use of a sledge and forming block and sometimes with the use of a flange clamp which for the heavier sheets requires heating. It is possible to purchase an air operated flanging machine which will handle all sheets up to one-half inch in thickness, cold and save many times the cost of the machine each year. There is practically no limit to the savings that would be revealed by a proper cost accounting system in the railroad shop.


Accumulating a Stock of Standard Piston Packing and Bull Rings

Cost accounting implies much and frightens the average shop man who pictures in his mind endless dry statistics compiled by a large staff of highly paid non-producers, all of whose wages go on the wrong side of the ledger. This is, of course, a wrong conception. There is no doubt in the writer's mind but that it would be profitable to have a complete inventory of any railroad shop compiled by an expert accountant setting forth original investment, and the cost of depreciation, overhead expense, supervision, etc., by departments with enough of the details of operation to determine whether the shop is a paying business. This, however, is not my idea in suggesting cost accounting at this time. As a beginning any well informed mechanic who has a taste for clerical work could make a study of one operation after another about the shop and make recommendations for improvements, suggest new machines or alterations in methods of procedure and back up his recommendations by figures together with catalogue references and prices in such a way as to enable the shop superintendent to handle the matter successfully with the head of the mechanical department. No doubt much of our lack of equipment is due to the fact that no proper information was ever given to the mechanical superintendent or general manager, or else it was given at the wrong time.

Fractures in Boiler Tubes*

After having run about 60,000 miles an engine of the Midland Railway came into the repair shops in the middle of 1919, the tube ends in the firebox being slightly burned and arrangements were made, as is the custom, to drive the tubes up from the smoke box end. At the first blow the end of the first large tube to be operated on fractured. Investigation showed that of the 21 large tubes, 8 had brittle ends, while 13 were fairly malleable.

The tubes were lap-welded, and it was obvious that the "steel tube strip" from which they were made was in both cases of poor quality. It will be appreciated that the use of this class of steel was entirely due to the war conditions prevailing. Microscopic examination showed that the impurities were largely concentrated in the boundaries between the crystals, and that the fractures were generally found to be intercrystalline.

Chemical analyses showed that tubes with brittle ends were unduly high in phosphorus, which was generally between 0.14 and 0.16 per cent, while tubes with malleable ends averaged 0.07 per cent of phosphorus. The amount of this impurity is extremely high, the maximum permissible under the specifications of the American Railway Association being 0.045 per cent of phosphorus.

It might be suggested that the brittleness of the tubes is due to the original stresses set up in expanding. In order to ascertain if this were the case, portions of two separate "brittle" tubes were taken from unaffected parts of the tube made into rings and expanded in the usual way. The Brinell hardness was in one case increased from 111 to 156, and in the other from 131 to 143, but in neither case did the metal become brittle.

The author suggests that the brittleness is due to the repeated stresses set up during the work of the locomotive, acting on material already in a state of stress, regard being had for the high phosphorus content of the metal. On the Midland Railway there are about 6,000 of these tubes in service, and with one odd exception, these eight tubes are the only ones known to be brittle. The phosphorus in the great majority of the tubes in use may be taken as being low.

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*From a paper by Sir Henry Fowler, presented before the Institution of Mechanical Engineers, London, Eng., and abstracted in the Iron Age.

Vitalizing Locomotives to Improve Operation

Present Conditions Can Only Be Met Successfully by Utilizing All Factors That Increase Capacity

BY GEORGE M. BASFORD

NOTHING our railroads have done in recent years is more potent in solving present and will be more effective in solving future transportation problems than the improvement in the locomotive and improvement in its operation. Nothing can prevent success. The railroads have clearly shown the way to reduce the cost of transportation by what they have already done. It remains to follow this path intensively. Transportation equipment is again coming to the test of the advance of a vast and growing nation. Vitalize the power that the country depends upon. Vitalize it to reduce cost. Vitalize it for increased capacity.

The times call for directness, for elimination of the unnecessary, for effectiveness, for efficiency. That the railroads have made wonderful progress should be made known to the public. That means are at hand for even greater accomplishments is known to every railroad man. Getting trains over the road has been the absorbing problem of the past. Getting them over the road and at lowest cost is the problem of the present and will be that of years to come. The locomotive of today is ready for its part in this.

Heavier Engines

For about 70 years there was no fundamental improvement in our locomotives in ways that made a pound of metal and a pound of coal do more work. For 70 years locomotives were small. They were well adapted to the service required. It was not severe service. The machine conformed closely with conditions of the time. When the heavy train load period came, engines were made larger, heavier and more powerful. For years the railroads had no other way to overcome increased cost of operation but by building larger locomotives. Costs went up and rates came down. This was met as long as it could be met by building larger and heavier engines. The public should be shown that this was done and well done. This continued until about 15 years ago when the largest locomotives reached the limit of the human fireman. This limitation revealed the necessity for providing higher efficiency.

Up to this time simplicity of construction was the designer's compelling rule. There could be no complication. Locomotives had to be as simple as a grindstone. The prejudice against so-called "complication" served, for a time, seriously to delay improvements, but far-seeing, courageous officials began to understand that certain results must be attained, and that well designed, well constructed improvements must be accepted and must be cared for in order to secure those results. This objection to complication is a relic of the past. It yielded when mere increase of size and weight did not suffice.

Successful Improvements

Until 19 years ago when the superheater made its advent on this continent, there was no persistent, systematic, successful improvement increasing the power capacity of the American locomotive, through increased efficiency in the use of heat.

With and largely as a result of the development of the superheater and the improvement of the arch came a revolution from rule of thumb to scientific design of locomotives as a whole. Heating surface, firebox volume, tube surface and boiler design throughout began to be based on the amount of steam the cylinders required. Other very important improvements became successful. Improved valve gears, automatic stokers, combustion chambers, firebox improvements, automatic fire doors, power reverse gears—all these have been brought to practical success during the present official generation. Latest of all are the feed water heater and the booster. The seven principal capacity increasing factors that mean most in the present situation that calls for capacity with efficiency and fuel conservation are the air brake, the superheater, brick arch, feed water heater, booster, mechanical stoker and light reciprocating parts of improved steel.

Six of these factors increase the capacity of the locomotive by increasing its horsepower and the air brake by making it possible to control long trains and by shortening stopping distance. They do not require increase in weight of rail or increase in strength of bridges. They are now playing a vital part in the welfare and the business of the country and they are helping and are ready to still further help reduce the cost of transportation.

That the policy of many railroads in recent years in equipping new engines and many old ones with two or more of the capacity increasing factors was eminently wise has been proven and judgment rendered. If this policy had not been adopted the record breaking ton mileage of the year 1920, without materially increasing the number of locomotives in service would have been impossible. It was the capacity increasing factors built into new locomotives of the past few years, the incorporation of these factors into many old engines, and the conversion of old engines into up-to-date ones that did it. This demonstration justifies the policy of equipping so many old engines with improvements that compel a ton of coal to do more work. That policy has made good completely. These capacity increasing factors are ready to do more than anybody realizes. Only the surface has been scratched.

This Is Ready Now

A certain large passenger locomotive, built five years ago, and which was up-to-date at that time, was being taxed to its capacity. It had reached its limit of load and speed. It had no reserve for bad weather or unusual conditions of service. A thorough study reveals the fact that this locomotive, already among the largest and most powerful of its class, may be replaced by one of the same type, but giving 58 per cent more starting drawbar pull, producing 30 per cent more drawbar pull at 60 miles per hour and with no more destructive effect upon the track than the present engine at 60 miles per hour, the destructive effect at 70 miles per hour, being less than that of the present engine. In this study absolutely nothing new or untried was contemplated. Refinement of design was considered, also enlarged capacity by a specially high degree of superheat, an improved firebox, the arch, light reciprocating parts of high grade steel, plus the booster to give greater starting power.

Think a moment of the operating advantages to be had from over 50 per cent more starting power and 30 per cent more drawbar pull at 60 miles per hour. This design did not include the feed water heater because it was not ready for consideration at the time. Heating the feed water by

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*From a paper presented before the New York Railroad Club, May 20, 1921.

waste steam would still further increase the power of this engine.

Any builder may build this engine. It is the first example, of which I have record, of a design for high power, which was prepared co-operatively by a railroad, a locomotive builder and by the engineers of the concerns which are devoting themselves to improvements for increasing capacity. Similar improvement is available to any railroad.

Of course, such a locomotive will cost more than a weak and obsolete one. It will, however, increase operating speed, reduce double heading, will apply high wage crews more effectively and will cheapen operation.

This increased power per engine will reduce the number of engines required to do a given amount of work. This will reduce maintenance. Obviously, it is easier to maintain two engines with these capacity increasing factors than to keep up three without them. The cost of these improvements is now going into coal and wages. It may go into new engines when by improving old ones the new ones will not for a time be needed.

Progress

Progress in the use the railroads are making of locomotive improvements is revealed by many examples of heavy trains and fast schedules. Here are three:

First: A well known road has increased its average revenue tonnage from 400 tons to 1,700 tons per train in 25 years, the maximum revenue tons handled in a regular train being 3,200. This road shows 233 per cent increase in weight of train and 66 per cent increase in speed in 25 years. It hauls 5,000 ton trains on 25 mile schedules. It makes excellent use of improved locomotives. In five years the average revenue train load of the country as a whole increased from 475 tons to 728 tons, or an increase of over 53 per cent since 1915.

Second: The 20th Century is the direct successor of the World's Fair Flyer of 1893 and represents continuous development. The weight of that train has increased 215 per cent and its speed has increased seven per cent. *Only an improved locomotive can haul it today.*

Third: Consider the fact that the heaviest passenger trains on one of the Western roads weigh 1,290 tons and are on fast schedules with maximum speed of 68 miles per hour. It is only 25 years ago that the newspaper men of New York were invited to see a 600 ton passenger train slowly pulled out of the Grand Central Terminal by what was then considered a monster locomotive. That locomotive is now hauling a milk train on a branch line. It and its class have given place to really powerful ones that were not then dreamed of. Today the fastest long distance trains in the country weigh twice as much as the exhibition train referred to. Until we are reminded of the past we do not appreciate what the railroads have accomplished.

Capacity First

In the usual sense of the expression saving fuel will not greatly reduce the cost of transportation, but conserving fuel by compelling every pound to yield more power will do so because it involves operation as well as engineering improvements. Power to get the maximum business delivered is the cheapest power. Heavy pulling at favorable speeds will reduce cost and as congestion increases, speed becomes a greater factor. Power to keep trains on time, to get through storms, to get in under the overtime limit is what is needed. Let us take a glance at some of the power increasing, capacity increasing factors with a view of giving the operating officer greater power capacity to work with. Many others are important and would be discussed here if time permitted.

Brick Arch

For many years arches have been used in locomotive fireboxes. Their function is to baffle the gases and flame on its way to the flues. They mix the gases from the fire, aiding combustion. They cause the burning of many of the cinders and they protect the flues from streams of cold air from the fire door, or from holes in the fire. They protect flue sheets and materially reduce honey-combing. Arches increase the heat making capacity of coal and reduce boiler failures, thus increasing the availability of engines. Success of the present arch and arch practice is due to structural improvements in the bricks themselves and in methods of support that renders renewal easy and to improved firebox design. Over 43,000 locomotives now have these arches. Every engine fit to run at all should be equipped on coming out of the shops if it did not have an arch when built. There is no other capacity increasing factor so easily and so inexpensively applied to existing locomotives.

Superheater

To this improvement the largest increase in locomotive capacity is due. The heavy trains of today could not be handled without superheaters. In June, 1910, the Superheater Company got fairly started. Since 1910 our railroads have applied 33,000 superheaters to new and old locomotives, about 90 per cent of new ones having been equipped during the past few years. The application to many more existing engines offers a promising opportunity to still further reduce the cost of transportation. It is a financial error to operate any locomotive today without a superheater, and the penalty is perpetuated as long as the engine runs.

Feed Water Heaters

This conservation factor is the first to utilize waste heat. It gives back to the boiler heat that is on its way to waste. For generations stationary and marine steam plants have used feed water heaters as a matter of course. The application to locomotives has been attempted many times and has waited only for practicable heater and pump. Thousands of European locomotives are already equipped and several thousand are being applied every year.

For over four years feed water heaters raising the temperature of the water from 40 to 50 degrees to from 230 to 250 degrees have been in successful service on locomotives in this country. These equipments also return for use again about 15 per cent of the exhaust steam in the form of water that has been distilled and filtered. This increase in the tender tank capacity is important in operating because of the ability to save some water stops.

Heat from the exhaust steam is returned to the boiler, giving the boiler less work to do. Therefore, less coal is burned to do a given amount of work or more work is done for the same amount of coal. Feed water heating is a success.

Booster

This capacity increaser is well named. It boosts a heavy train in starting and also on the critical points on grades. It is the latest improvement. It supplies an ideal method of utilizing weight and steam that is not needed for other purposes at low speeds and only at the time that the boost is wanted.

When the train is going the demand for steam is greatest. Immense boilers are needed at speeds. There is a surplus of boiler power when starting and at low speeds. The big boiler requires trailing wheels to carry it. This weight on trailing wheels is also a surplus when starting or when running slowly. The booster couples up this surplus steam and idle weight, making both useful to get the train going and to keep it from stalling on ruling grades. Usually there are a few points on a division which determine the load an engine can haul over the entire division. If these are mastered the rest is easy. This is one of the booster functions. Another is in starting a heavy train, getting it out of a siding or through the switches of a yard. Here is where the 70 to 100 feet of slack between the cars of a long train causes havoc with draft gear. The booster works like an automobile in low gear. It applies its extra power smoothly, avoiding the jerks that a big engine otherwise must give to get going at all.

Again, it solves the problem of the big passenger engine. With 20 to 25 per cent more starting power backing up to take slack is avoided, eliminating the frequent five to 10 minutes' delay in getting a heavy train moving every time it stops. Operating men will appreciate this advantage, especially when they have big passenger trains in several sections, each losing minutes every time they start, especially when they start on grades.

The booster will help keep passenger trains on schedule and the road clear for freight. It puts in your hand the means for placing any engine having trailing wheels into the class above itself in starting capacity. It is as good as another pair of drivers but avoids the larger cylinders, heavier rods and extra weight that these drivers entail and which are wanted only in starting. In fact the booster is better than another pair of drivers because it changes trailing wheels into drivers when wanted, and then changes them back into trailers when the pull is reduced after the wheels are rolling. This is conservation of the highest order.

Control is semi-automatic, giving the enginemen the maximum resource for starting power and a negligible minimum of attention or mental effort. Tests on a large railroad show for the booster the following results on a Pacific type freight engine:

1. An increase of 23 per cent in train tonnage, or
2. An increase of 12 per cent in speed on the division in question.
3. An increase of 18 per cent in drawbar pull at 7½ miles per hour.
4. An increase of 13 per cent in drawbar pull at 13 miles per hour.
5. An increase of 22 per cent in starting power.

It is an important tonnage increaser. It is capable of doing more to reduce the cost of transportation than any locomotive improvement except the superheater, and it does more to supplement the superheater than any other factor available.

David L. Barnes will long be remembered for advocating the wide firebox for locomotives. The change "came hard." Dr. Goss helped it immensely with his grate area test at Purdue. At first fireboxes were extended over the frames, but this was not enough. In those days locomotives had leading trucks and the rest of the wheels were drivers. The real wide firebox, needed for steam making at speed, brought the trailer axle with its "idle" wheels. We hated the thought of wheels under a locomotive that did not work. This explains the struggle of the Prairie type which persisted until distrust of pony trucks at high speeds effectively buried that type of engine. We gave up not gracefully but under force. Next we became blind to the "idle" weight and went ahead until the country has a lot of it. The booster has given back what was lost and more. The booster uses this idle weight by applying power to the trailers.

Someone will say: "You are talking power and more power. We have too much power now and are compelled to run big, powerful Pacific type engines on light local passenger trains of five and six cars." Let me answer "yes." This work is being done with big engines because lighter ones will not make the time with the frequent stops of local trains. Put boosters on old Atlantic type and the lightest Pacific type engines that have been superheated and do this work with these engines that are suitable for it.

Increase of Capacity

The accumulated increase of capacity due to the superheater, arch, feed water heater and booster in indicated in Fig. 1. At 45 miles per hour the increased power due to these factors is 79.7 per cent, when they are applied in combination. This is now considered too high speed for such a heavy engine. These combined curves indicate that at 30 miles per hour the power increase for the same coal is 50 per cent, at 25 miles per hour 40 per cent, at 20 miles per hour 29 per cent. The diagram also shows the increase in the speed possible with the same load and fuel in case speed rather than heavier loading is wanted. At 30 miles per hour two engines completely equipped give as much power as three "plain" engines. The increased power in this case costs half that of another plain engine and the cost of maintaining two sets of improvements will be less than the cost of maintaining another complete plain engine. The base engine in the case is the Administration light Mikado, as it would appear if built without any of the improvements we are discussing. If greater drawbar pull, due to these improvements, is not desired, the curves show the increased speed that may be had with any given pull.

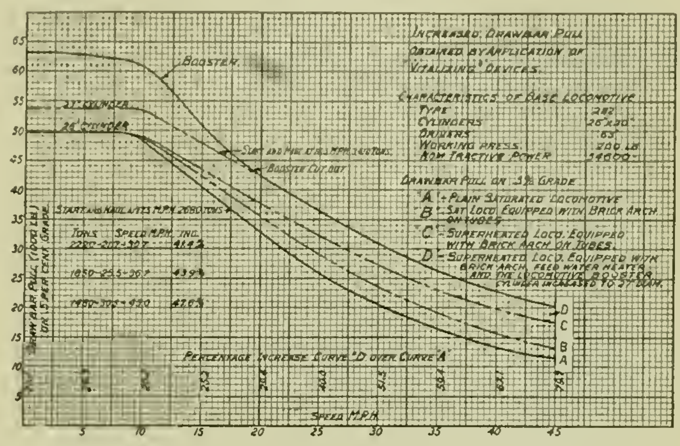


Fig. 1—Increased Drawbar Pull Obtained With Capacity Increasing Devices

Fig. 2 outlines an engine equipped to give this power.

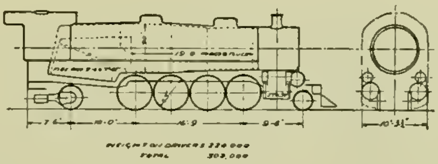


Fig. 2—A Typical Improved High Capacity Locomotive

The absurdity of trying to get it without the efficiency factors is shown in Fig. 3. This engine (Fig. 3) is as "simple as a grindstone." A plain engine to do this work would be a freak that could not be put on any railroad. Look at the wheels, the flue length, the size of the firebox and then think of what this means. I cannot present a better demonstration.

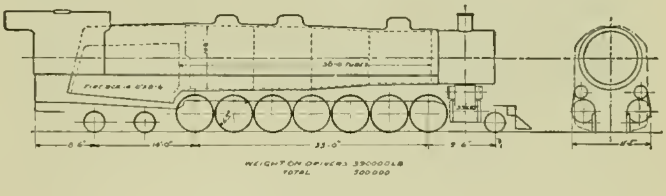


Fig. 3—A Plain Saturated Locomotive to Deliver the Same Drawbar Pull at 45 Miles an Hour as the Engine Shown in Fig. 2

The fuel consumption as affected by these capacity factors is shown in Fig. 4. Of course, increased power means stronger cars, longer sidings and removal of other physical restrictions which in every case are paying business propositions.

High Quality Steel Reciprocating Parts

High quality steel forgings if applied to the reciprocating parts of the United States Railroad Administration heavy Mikado locomotives reveal an interesting possibility. Both light and heavy Administration Mikados were actually built with reciprocating parts of open hearth steel. The results in rail pressures which would be obtained if the heavy Administration engine had been built with high quality steel reciprocating parts of light weight are shown in Fig 5. The first sets of figures show the rail pressures of the light Mikado with open hearth reciprocating parts at rest and at different speeds. The lower figures in each case show the rail pressures of the heavy Administration Mikado if fitted with light parts of high quality steel. These are shown at rest and at speeds of 35, 40, 45 and 55 miles per hour. At speeds between 40 and 45 miles per hour the light Mikado becomes more destructive to the track because of driving wheel pressures than the heavy Mikado when equipped with light reciprocating parts. In other words, at all speeds where the engines are likely to damage the track the heavy Mikados with light parts are safer engines than the light Mikados with heavy parts. In this comparison, it should be borne in mind that the heavy Mikado has 10 per cent more tractive power than the light one and 14 per cent more heating surface. The total weight of the heavy Mikado is 9½ per cent greater than the light one. As railroad officers with track and bridge responsibilities, which engine would you choose? Remember that the heavy one has 10 to 15 per cent greater capacity than the light one.

Stokers

Locomotives of greatest power when coal is the fuel have passed the physical capacity of the fireman to maintain steam enough to supply the large cylinders that present operating conditions demand. As the result of development in the severest service known, mechanical stokers are ready not only for present needs but they provide reserve capacity for years to come. In considering the stoker, the chief question is one of increased capacity to get the power from the tender to the grates, in order to get the greatest loads over the road at the least cost. The vital question is the provision of the horsepower at speeds that bring economy in use of tracks and yards and economy in the application of high wage schedules and prohibitive overtime. The stoker development began at about the right time to be ready for power demands that are coming. Power stokers emancipate the big locomotive from the limitations of the human fireman. They render it possible to operate locomotives that require too much coal for the ablest of firemen to handle. They also provide means for getting higher horsepower out of engines at high speeds than otherwise would be possible.

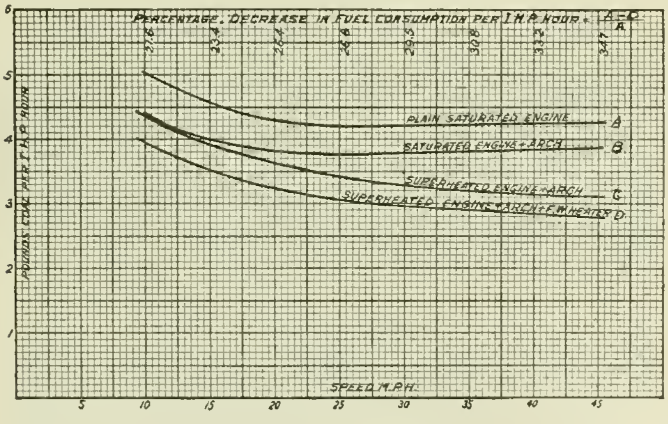
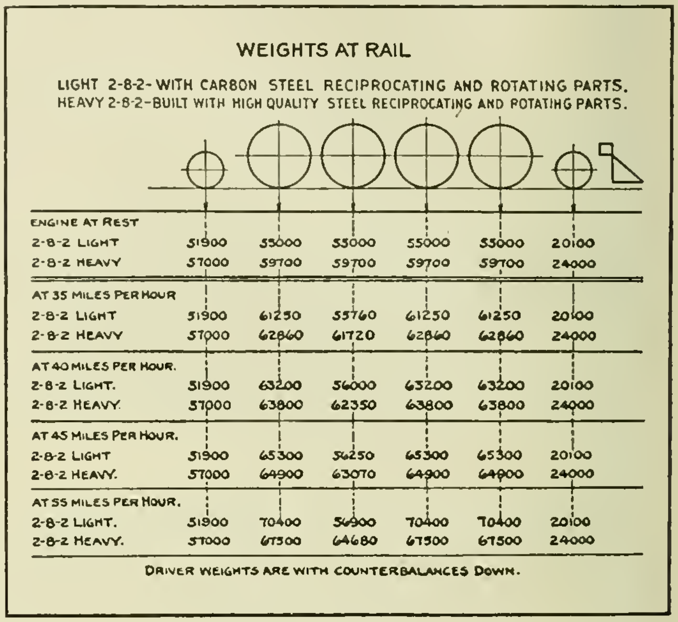


Fig. 4—Fuel Consumption of Locomotives With and Without Power-Increasing Factors

Air Brakes

Air brakes have increased the capacity as well as safety of railroads. By improved brakes alone the capacity of the New York Subway was more than doubled. Without highly efficient air brakes heavy trains could not be run at all. This great subject is merely mentioned here, but it must be considered in connection with the future because today the improved equipment of brakes is in the lead of common practice.



WEIGHTS AT RAIL

LIGHT 2-8-2-WITH CARBON STEEL RECIPROCATING AND ROTATING PARTS.
HEAVY 2-8-2-BUILT WITH HIGH QUALITY STEEL RECIPROCATING AND ROTATING PARTS.

ENGINE AT REST						
2-8-2 LIGHT	51900	55000	55000	55000	55000	20100
2-8-2 HEAVY	57000	59700	59700	59700	59700	24000
AT 35 MILES PER HOUR						
2-8-2 LIGHT	51900	61250	55760	61250	61250	20100
2-8-2 HEAVY	57000	62860	61720	62860	62860	24000
AT 40 MILES PER HOUR.						
2-8-2 LIGHT.	51900	63200	56000	63200	63200	20100
2-8-2 HEAVY.	57000	63800	62350	63800	63800	24000
AT 45 MILES PER HOUR.						
2-8-2 LIGHT	51900	65300	56250	65300	65300	20100
2-8-2 HEAVY.	57000	64900	63070	64900	64900	24000
AT 55 MILES PER HOUR.						
2-8-2 LIGHT.	51900	70400	56900	70400	70400	20100
2-8-2 HEAVY.	57000	67500	64680	67500	67500	24000

DRIVER WEIGHTS ARE WITH COUNTERBALANCES DOWN.

Fig. 5—Decrease in Rail Pressure Effected by Using High Quality Steel

Look Forward

New locomotives are going to last almost indefinitely when kept up-to-date as to modernizing. They lose their useful lives only by obsolescence. The design of new equipment is therefore of the utmost importance and someone on the road should be charged with the responsibility of looking ahead and determining what new engines are to be, long enough in advance to be sure that they absolutely fit conditions as they are and that they will fit as nearly as may be conditions that are to come. This involves a deep study of operation in all its phases. It seems obvious that the general manager or operating vice-president would find his job much easier if every new engine built should receive the same attention that the building of every new big bridge receives. But bridge design is a routine. Locomotive design is improving so fast that most of us cannot keep up with it. The new engine question in itself is a big task, offering great possibilities.

Then comes the question of the existing power and what may be done to it to increase its capacity, increase its pulling power, reduce its failures on the road, to quicken and cheapen the maintenance work and to increase its thermal efficiency and the number of hours that it is available. This involves intimate knowledge of progress in machine tools, in labor-saving equipment, in equipment of locomotive terminals and particularly equipment for running repairs at the roundhouses. Some of the roads are approaching this ideal now. The roads which come nearest to doing it are those which are making best use of their power, and which are in the best shape financially.

The kind of problems which need working out are represented by a study of locomotive drawbar pull which will show whether it is cheaper to increase the power of locomotives or to cut down a certain grade. The money value in reduced cost of operation due to reducing certain grades is already well worked out. It is practically reduced to a formula, but the effect of increased drawbar pull needs to be reduced to a formula. This would at once reveal the money value in operation of increasing the drawbar pull of a Mikado by 50 per cent at a speed of 30 miles per hour or by nearly 30 per cent at 20 miles per hour. Another study of great value is that of considering available drawbar pull hours of locomotives as if it were a deposit in the bank. Figures that show how much of this deposit is used under daily conditions and how much it can be increased by relatively small expenditures offer a promising field for saving.

Because of the improvements of 20 years the locomotive, its construction, its operation and its maintenance presents the trump card in the reduction of the cost of transportation in the present emergency. That card has been well played, play it now to win.

In conclusion there are two very important points which I do not wish to leave either unsaid or unheeded:

First: In emphasizing the importance of all these items of modernizing, of vitalizing, locomotives we have discussed tonight, I wish to make most prominent the first and greatest obligation of the railroad companies, namely, their responsibility to their owners and stockholders, who first and above all others are entitled to a fair return upon their investments.

Second: As I have already attempted to point out railroad managements have done and are doing wonderfully well in the application of capacity increasing factors to locomotives to augment power. These improvements will by necessity result in substantial savings. There are, however, additional means of economy which are not so closely hooked up with pure problems of capacity increase. These must be further considered by themselves. Funds for carrying out programs in this direction will be made available quickly when the possibilities and necessities are fully appreciated.

Discussion

W. E. Woodard (Lima Locomotive Works): One of the most marked results of the developments so clearly shown in this paper is the effect of these developments on the speed of the locomotive. For example, Fig. 1 indicates that a thoroughly modernized locomotive is good for an increased speed of from 40 to 48 per cent with the same train load over a plain locomotive; and this using the same amount of coal.

Railway operating officers are now realizing as never before the value of intensive railroading. "Speed up operations to increase earnings" is their aim because they realize that there is a sound economic basis for so doing. Overhead charges are fixed. Administration expenses, roadway, signals, terminals and cost of equipment are stationary. No matter how many cars are moved over the line charges on this overhead must be paid. It is a definite sum for every hour in the day. The more productive work that can be crowded into the hour, the more cars hauled, the more economical is the operation. It is almost exactly analogous to a manufacturing plant where high-speed tools and quick handling of the products is absolutely essential to economic production. The railway executives, the roadway, the signals, the terminals and the equipment are the plant. Locomotives are the tools.

The locomotive is the most important single item in speeding up production; other factors, such as terminals, signals, roadway, are contributory factors. They can hold back the speed of production, but in and of themselves, they cannot get speed of production without locomotives suitable for the job. I realize, of course, that there is a limit beyond which freight train speeds are not economical, the same as speed of production in a manufacturing plant is limited by the strength of the tools and other physical conditions of the equipment.

The diagrams clearly show that every one of the developments mentioned by Mr. Basford has been a decisive factor in the speeding up process. The booster, one of the latest of the developments, lends itself most admirably to this need. It can be applied to a locomotive whose characteristics are suitable for high freight train operating speeds and give it the starting power of a heavy drag freight locomotive.

I looked at Fig. 3—the absurdly impossible design of plain saturated locomotive, and my first thought was to question the accuracy of the showing. I dug up a 1906 Locomotive Dictionary and picked out ten of the best designs illustrated. For that time they were good locomotives—the best in the country on the best lines. These engines showed from 65 to 77 h.p. per 10,000 lb. weight of engine. Fig. 3 gives 70 h.p. per 10,000 lb. weight of locomotive. In other words, Fig. 3 compares very favorably with the best of the 1906 engines for horsepower output per 10,000 lb. of weight. At the present time we are getting 95 h.p. per 10,000 lb. of engine weight. With all the modern developments on a locomotive we can get over 100 h.p. per 10,000 lb. of weight. Fig. 2 gives 101 h.p. This increase in horsepower per unit of weight is the real measure of the development. The things Mr. Basford has been talking about have put up the horsepower output from 70 per 10,000 lb. to over 100, and that is the factor which really counts in railroad production. Capacity, which to the engineer means horsepower; which to the railroad executives means cars per hour, or tonnage production, is the answer to our railroad problem. It is one thing the railroads themselves can control, and with it they can get the answer.

D. F. Crawford (Locomotive Stoker Company) reviewed the increase in the average train load during a period of 30 years. He pointed out that the development of the stoker was brought about to increase still further the tons per train. As locomotives increased in size the full benefit of the additional tractive effort was not realized in operation with hand fired engines. The stoker furnished a means of getting full capacity from each unit as it removed limitations on the quantity of coal that could be fired in a given time. Mr. Crawford pointed out that while combustion efficiency is lower at high rates of firing, the increased consumption of fuel is less important than the increased capacity of the motive power. Under suitable conditions from 15 to 20 per cent increase in train load can be gained by the use of the stoker. If it is not desirable to increase the train load, the stoker can be used as a means of decreasing the time on the road with the same rating.

W. L. Bean (N. Y., N. H. & H.) spoke on the practical limitations in the application of devices to increase capacity. He stated that full benefit cannot be derived from these appliances unless the locomotive can be operated nearly at its full capacity. The railroads had adopted devices that would effect economies as soon as they were developed to insure satisfactory reliability. Where the traffic is heavy and the service regular, all the accessories mentioned by Mr. Basford could be used profitably but in some classes of service they were not applicable. Mr. Bean touched on the maintenance problem stating that modern locomotives demand adequate facilities for maintenance and require that the forces be educated to keep them in condition. As the design of locomotives improves, the facilities must be developed concurrently; otherwise the savings obtained under test conditions vanish in service and are absorbed in routine charges so that the loss is not noticed. He told of the excellent results obtained with feed water heaters in freight service where the saving in water consumption made it possible to run 65 miles between water stops in freight service.

Air Brake Association Holds Executive Meeting

Papers Are Presented Without Discussion; Report of Extensive Tests of Steam Heating Apparatus

IN lieu of the twenty-ninth annual convention, which was postponed because of the prevailing business depression, the Executive Committee of the Air Brake Association held an open meeting at the Hotel Sherman, Chicago, on May 3, for the conduct of the essential business of the Association and to receive the committee reports and papers prepared for presentation and discussion at this year's convention. The reports and papers were presented in abstract only and were received without action or discussion, it being the plan of the executive committee to issue them to the membership in proceedings form and to bring them up at the next regular convention for final disposition by the membership as a whole.

The following reports and papers were presented:

Report of the Committee on Recommended Practice; Tests of Steam Heating Apparatus on Locomotives and Passenger Cars, Montreal Air Brake Club; Terminal Tests to Insure Effective as Well as Operative Brakes, Pittsburgh Air Brake Club; The Schedule "U C" Brake; the Brake Pipe Vent Valve, Central Air Brake Club; and Report on Air Consumption of Locomotive Auxiliary Devices.

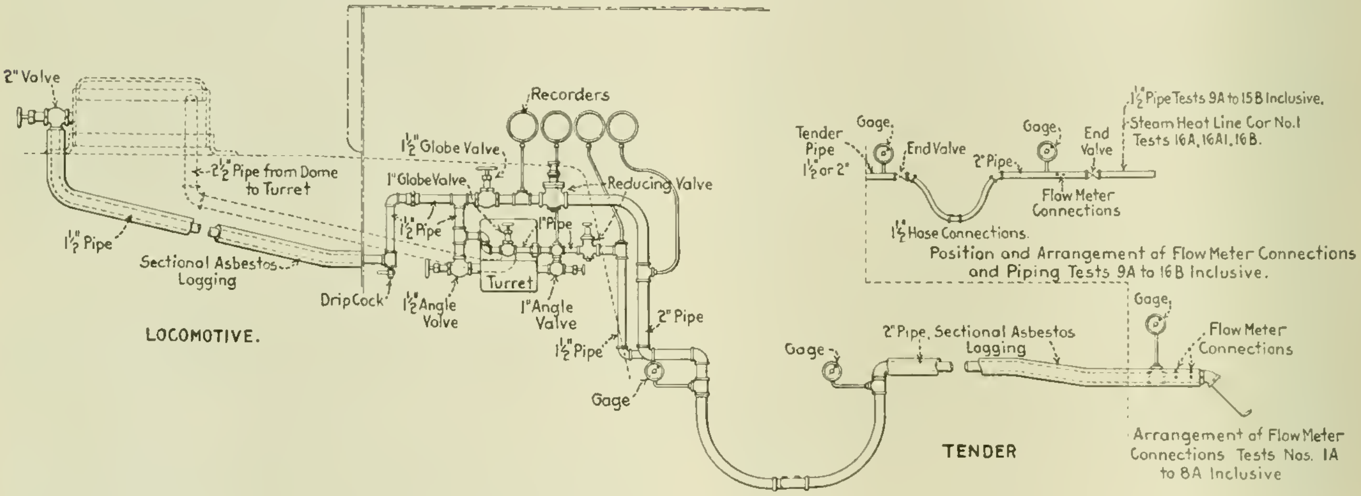


Diagram of Locomotive and Tender Piping and Fittings

The paper describing the tests of steam heating apparatus conducted by the Montreal Air Brake Club is abstracted below and other reports will be published in the July issue.

Tests of Steam Heating Apparatus

Submitted by the Montreal Air Brake Club.

A committee of the Montreal Air Brake Club was appointed to investigate to what extent improper size of piping, starting valve, steam heating reducing valve and flexible conduits interferes with the heating of passenger trains by steam from the locomotive. The committee was able, through the courtesy of the Canadian Pacific, to complete a set of tests during the month of November, 1920.

The committee has concluded its work. On the contrary, there is much remaining to be done, but it is considered, owing to the importance of some of the features brought to light, that the facts should without further delay be made available to all concerned.

The particular points upon which information has been sought to date might be listed as follows:

First—Comparison of capacities of 1½ in. and 2 in. steam pipes on locomotives and tenders, 1 in. by 1½ in; 1½ in. by 1½ in. and 1½ in. by 2 in. regulating valves, 1½ in. standard steam hose and 1½ in. and 2 in. metallic connections between engine and tender.

Second—After determining what appears to be the most suitable combination of locomotive steam heat apparatus available, whether such combination with present standard adjustments of regulating valve is of adequate capacity for modern train lengths and the extremely low temperatures occasionally met.

Third—To what extent can the capacity of locomotive apparatus be increased by higher adjustment of regulating valves, and changing of locomotives at terminals be facilitated thereby?

The equipment of the test train consisted of Canadian Pacific passenger locomotive No. 2596 and the following 18 cars, selected without regard to construction or type of heating system:

	Construction	Heating system
Baggage	Wood	Gold
Sleeper	Wood	Gold
Diner	Wood	Gold
Tourist	Wood	Gold
Diner	Wood	Gold
Diner	Wood	Gold
Diner	Wood	Gold
Diner	Wood	Gold
Tourist	Steel	Vapor
Diner	Wood	Gold
Tourist	Steel	Vapor
Tourist	Steel	Vapor
Tourist	Wood	Gold
Tourist	Wood	Gold
Sleeper	Wood	Commingler
Diner	Wood	Gold
Sleeper	Wood	Commingler
Sleeper	Wood	Gold

All tests were made with the train at rest, on two adjoining tracks in the Glen Yards at Montreal. The engine and nine cars occupied one track, the connection to the remaining cars being made with 18 ft. of 2-in. pipe, heavily insulated.

Total length of 2-in. main steam pipe under cars	1,398 ft.
Total length of hose on 18-car train	87 ft. 6 in.
Total length of radiating pipe inside of cars	3,540 ft. 6 in.
Total	5,035 ft.

The train was equipped throughout with positive lock couplings with gravity release trap.

A diagram of the locomotive and tender piping, as well

TABLE NO. 1—STEAM HEAT TRAIN LINE CHARGING TESTS

Test of	Normal temperature, deg. F.	Duration		Type and size connection between engine and tender	Size of steam pipes, in		Steam from turret or dome	Injector or blower operated	Size and type of regulator	Size of steam valve, in.	Steam valves inside car	Gage and recorder readings on locomotive, lb. per sq. in.													Flow meter readings		Gage readings on cars, lb. per sq. in.													
		Min.	Sec.		Engine	Tender						Boiler pressure			Regulator				Rear of engine		Front of tender		Back of tender		Av. flow lb. steam per min.	Equivalent boiler h. p. (per hour)	Rear of													
															Ahead of		Back of										Car 5		Car 10		Car 12		Car 14		Car 16		Car 18			
Test of 18-car train—																																								
1 A	42	40	5	Hose 1½	2	2	Turret	No	Type B, 1 by 1½	1	Open	190	190	180	172	162	64	59	57	52	55	50	55	50	20.7	42.5	..	18	..	5	..	*	..	*	..	*	..	*		
3 A	40	45	..	Hose 1½	2	2	Turret	No	Type B, 1½ by 2	1½	Open	195	195	183	186	174	61	58	55	57	52	54	52	52	21.7	44.8	14	20	..	1	..	*	..	*	..	*	..	*		
3 B	41	6	21	Hose 1½	2	2	Turret	No	Type B, 1½ by 2	1½	Open	193	193	188	178	175	93	89	90	88	85	84	83	82	31.7	65.9	31	34	..	5	..	*	..	*	..	*	..	*		
4 A	42	25	47	Hose 1½	2	2	Turret	No	Type C, 1½ by 2	1½	Open	195	195	188	186	180	57	58	56	57	52	54	52	54	21.7	44.9	13	22	..	3	..	*	..	*	..	*	..	*		
4 B	43	15	..	Hose 1½	2	2	Turret	No	Type C, 1½ by 2	1½	Open	190	190	188	175	175	86	88	85	87	82	82	80	80	30.6	63.5	26	36	..	3	..	*	..	*	..	*	..	*		
5 A	43	11	50	Hose 1½	2	2	Dome	No	Type C, 1½ by 2	1½	Open	195	195	190	180	175	90	88	87	87	82	83	81	83	31.5	65.4	28	37	..	5	..	*	..	*	..	*	..	*		
Test of 9-car train—																											Car 3		Car 5		Car 7		Car 9							
7 A	31	1	38	Hose 1½	2	2	Turret	No	Type C, 1½ by 2	1½	Open	182	182	182	150	150	59	59	53	58	53	54	..	..	**	....	..	27	..	14	..	*	..	*	..	..	..	..		
7 B	29	1	44	Hose 1½	2	2	Dome	No	Type C, 1½ by 2	1½	Open	**	**	**	**	**	**	**	**	**	**	54	..	..	**	....	..	25	..	13	..	*	..	*						
8 A	29	2	6	Hose 1½	2	2	Turret	Both	Type C, 1½ by 2	1½	Open	195	190	180	150	142	59	59	59	59	52	54	..	..	**	....	..	26	..	12	..	*	..	*						
Test of locomotive equipment—																											At flow meter													
9 A	30	5	..	Hose 1½	2	2	Turret	No	Type B, 1½ by 2	1½	.....	190	190	190	152	152	60	60	59	59	46	46	44	44	43	88.3	37	34												
9 B	39	5	..	Hose 1½	1½	1½	Turret	No	Type B, 1½ by 1½	1½	.....	198	198	198	167	167	60	60	54	54	45	45	38	38	23	47.0	30	30												
10 A	30	5	..	Met. E 2	2	2	Turret	No	Type B, 1½ by 2	1½	.....	190	190	183	150	143	60	62	59	57	49	47	46	45	45.4	92.3	34	32												
10 B	39	5	..	Met. E 1½	2	2	Turret	No	Type B, 1½ by 2	1½	.....	195	195	193	162	160	60	58	57	56	40	39	38	38	32	65.5	30	29												
11 A	30	5	..	Met. D 2	2	2	Turret	No	Type B, 1½ by 2	1½	.....	195	195	185	155	145	61	61	57	57	52	52	50	50	47.7	97.9	37	37												
11 B	43	5	..	Met. D 1½	2	2	Turret	No	Type B, 1½ by 2	1½	.....	200	200	195	165	160	59	59	56	56	45	45	44	44	39.5	81.1	34	33												
12 A	42	5	..	Met. E 1½	1½	1½	Turret	No	Type B, 1½ by 1½	1½	.....	195	195	193	167	165	60	61	52	50	37	39	32	33	20	40.9	25	27												
12 B	40	5	..	Met. D 1½	1½	1½	Turret	No	Type B, 1½ by 1½	1½	.....	195	195	190	163	158	60	60	53	53	44	45	39	39	22.5	45.0	30	30												
13 A	48	5	..	Hose 1½	1½	1½	Turret	No	Type B, 1 by 1½	1	.....	..	193	188	155	150	59	57	52	51	42	41	40	39	22.9	46.3	29	29												
13 B	49	5	..	Hose 1½	1½	1½	Turret	No	Type B, 1 by 1½	1	.....	..	190	180	145	138	76	69	66	61	55	51	50	46	26.3	54.0	38	35												
14 A	47	5	..	Met. D 1½	1½	1½	Dome	No	Type A, 1½ by 1½	1½	.....	..	193	188	159	154	60	60	52	53	42	43	37	39	22.4	45.8	29	30												
14 A1	49	5	..	Met. D 1½	1½	1½	Turret	No	Type A, 1½ by 1½	1½	.....	..	198	193	165	160	60	60	53	53	43	43	38	38	23	47.1	30	30												
14 A2	48	5	..	Met. D 1½	1½	1½	Turret	Both	Type A, 1½ by 1½	1½	.....	..	190	182	150	141	61	61	53	54	43	44	39	39	23	47.1	30	30												
14 B	48	5	..	Met. D 2	2	2	Dome	No	Type A, 1½ by 2	1½	.....	..	195	190	158	153	60	60	56	57	52	53	50	50	44.5	91.3	37	37												
14 B1	49	5	..	Met. D 2	2	2	Dome	No	Type A, 1½ by 2	1½	.....	..	200	200	130	130	122	121	115	112	108	105	102	100	83.1	172.4	79	78												
14 B2	46	5	..	Met. D 2	2	2	Turret	No	Type A, 1½ by 2	1½	.....	..	195	185	155	145	60	61	57	57	54	54	50	50	45.7	93.8	38	38												
14 B3	47	5	..	Met. D 2	2	2	Turret	Both	Type A, 1½ by 2	1½	.....	..	195	177	140	127	62	61	58	56	55	53	51	51	45.7	93.8	38	38												
15 A	48	5	..	Met. D 1½	1½	1½	Dome	No	Type B, 1½ by 1½	1½	....	..	197	191	165	159	60	59	52	51	43	41	38	38	22.2	45.5	29	29												
15 A1	48	5	..	Met. D 1½	1½	1½	Dome	No	Type B, 1½ by 1½	1½	.....	..	200	200	140	140	128	128	119	114	100	97	89	90	44.9	92.9	75	70												
15 B	48	5	..	Met. D 2	2	2	Dome	No	Type B, 1½ by 2	1½	.....	..	195	190	158	153	59	59	56	57	53	54	51	51	46	94.4	38	38												
Test of 13-car train—																											At flow meter		Car 3		Car 5		Car 7		Car 10		Car 12		Car 13	
16 A	38	..	..	Met. D 2	2	2	Turret	No	Type A, 1½ by 2	1½	Open	198	198	148	165	119	79	75	75	73	72	71	71	72	38	78.6	71	71	37	42	6	15	**	**	2	10	..	8	..	8
16 A1	35	..	..	Met. D 2	2	2	Turret	No	Type A, 1½ by 2	1½	Open	193	193	186	156	144	115	115	112	112	107	109	104	105	55.4	115.5	100	102	58	67	21	32	**	**	..	15	..	9	..	8
16 B	35	..	..	Met. D 2	2	2	Turret	No	Type C, 1½ by 2	1½	Open	195	195	168	162	130	80	78	78	76	75	74	74	73	39	80.7	70	69	39	45	7	17	**	**	..	10	..	8	..	8

*Steam, no pressure. **No readings.

Notes:

Boiler gage readings were taken before test started, at start of test, and at finish of test and recorded in this order in the three columns under Boiler Pressure.

Gage reading on Tests 1A, 7A, 7B, 8A, were taken immediately test was started, and at end of test. All other gage readings were taken two minutes after test started, and at end of test and recorded in these orders in the columns under their respective headings.

Duration of Tests Nos. 16 A, 16 A1, 16 B

	Time to get steam at end of 13th car	Time to raise pressure from 0 to 5 lb.	Time to raise pressure from 0 to 8 lb.
16 A	5m 13s.	19m. 45s.	31m. 30s.
16 A1	4m. 57s.	8m. 0s.	9m. 15s.
16 B	6m. 16s.	16m. 30s.	21m. 8s.

as the location of recording instruments is shown in the drawing.

The capacity of the various combinations of locomotive apparatus was determined with a General Electric Company's Type T Flow Meter.

As shown on the diagram, the flow meter was located between the tender and first car, when the engine was coupled to the train, and when testing the engine alone, a piece of 2 in. pipe, 36 in. long, with standard 1½ in. by 2 in. end valve on one end and standard steam hose on the opposite end was coupled to the steam hose at the rear of the tender. The end valve was fully open during all tests, allowing steam to pass freely to atmosphere.

In case of the 18 and 9 car trains, all of the tests consisted simply of taking the time between the admission of steam to the head end of the train and its appearance at the different gage locations, as well as the hose coupling at the rear of the last car, the steam valves inside of the car being fully opened during this interval.

Table 1 is a tabulation of the details of each test and notes the class of equipment on the locomotive. The figures under "Equivalent Boiler Horse Power" represent the total power that would have been supplied for one hour, had the individual tests been continued for that length of time.

The table comprises the complete information in the hands of the committee, with the exception of the two-minute readings at each gage; these readings were, however, taken for checking purposes and the figures recorded in the table at the beginning and end of tests are taken from the detailed readings.

Chart 1 shows the pressure loss in pounds per square inch in the steam pipes and connections between engine and tender.

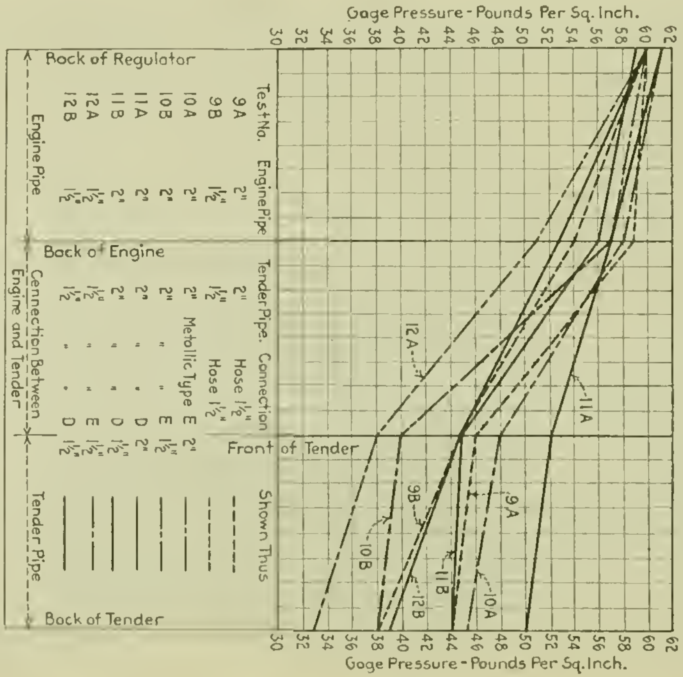


Chart 1.—Loss of Pressure on Locomotive Equipment, Back of Regulator to Back of Tender

These tests were run with the same type of regulator, a 1½ in. by 1½ in. regulator being used for 1½ in. piping, and a 1½ in. by 2 in. regulator for the 2 in. piping. This sheet shows that with 2 in. piping and 2 in. connections, as in tests 10-A and 11-A, a steady pressure drop was experienced and a fairly constant flow of steam obtained. A similar result is obtained when 1½ in. piping and 1½ in. connections were used (see tests 9-B, 12-A and 12-B), the pressure drop, however, being far greater than in the previous named tests. When 2 in. piping was used, with 1½ in. connections (see tests 9-A, 10-B and 11-B), the pressure drop in the 2 in. pipe was much less than in the 1½ in. connections, the resulting drop, however, being more than with 2 in. pipe throughout, but less than with 1½ in. pipe throughout.

Chart 2 shows the difference between the various type of connections, between engine and tender with various sizes of piping. It can readily be seen that 2 in. pipes on both engine and tender are more efficient than 1½ in. pipes, and that the ideal arrangement (as far as capacity is concerned and considering the equipment available at the test), is to have a 2 in. metallic connection such as the type D between engine and tender, the losses being far less with this combination than others noted. The 1½ in. hose and 1½ in. metallic connections between engine and tender compare favorably, the latter having a little advantage. The 1½ in. piping on engine and tender shows a great loss both in pressure and flow of steam and, therefore, cannot be recommended as good practice.

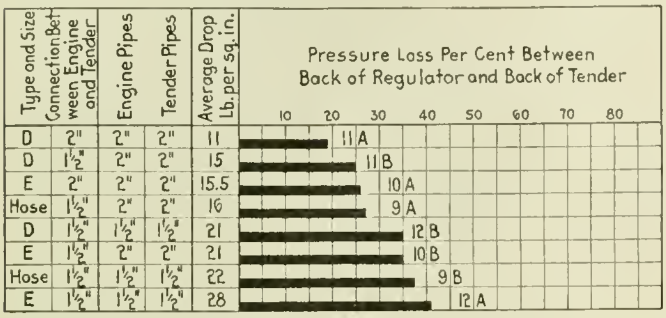


Chart II.—Pressure Losses and Locomotive with Various Sizes of Piping

Chart 3 shows the relative efficiencies of the connections between engine and tender, the 2 in. metallic type D showing about double the efficiency of the 1½ in. metallic of the same type.

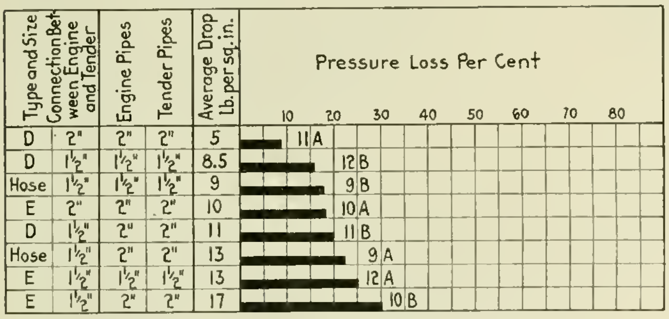


Chart III.—Pressure Loss in Connections Between Engine and Tender

Chart 4 shows the capacity of the locomotive equipment with various adjustments and sizes of regulators. It can be readily seen that the 1 in. by 1½ in. regulator at maximum capacity using 1½ in. engine and tender pipe, delivers only about 57½ per cent of the 1½ in. by 2 in. regulator, adjusted at 60 lb., using 2 in. engine and tender pipe. The 1½ in. by 1½ in. regulator at maximum capacity with 1½ in. piping, is about equal to the 1½ in. by 2 in. regulator, adjusted at 60 lb. The 2 in. pipe combination with 1½ in. by 2 in. regulator, adjusted at maximum capacity delivered steam equivalent to 172 boiler horse power or 4,986 lb. of water per hour.

Chart 5 covers Tests 16-A-1 and 16-B and shows the time consumed in forcing steam through the train, the pressure variations in the train line, as well as the time to accumulate pressure at the rear of the last car, and finally the pressure at the termination of the test when 8 lb. had been obtained at the rear car.

A distinguishing feature of the 16-A-1 and 16-B readings is that with 115 lb. adjustment of regulating valve, 55.4 lb. of steam per minute, or at the rate of 3,324 lh. per hour passed into the steam train line and with 80 lb. adjustment, 39 lb. per minute, or 2,340 lb. per hour, which is only about 70½ per cent of the weight of the volume delivered with the higher regulating valve adjustment.

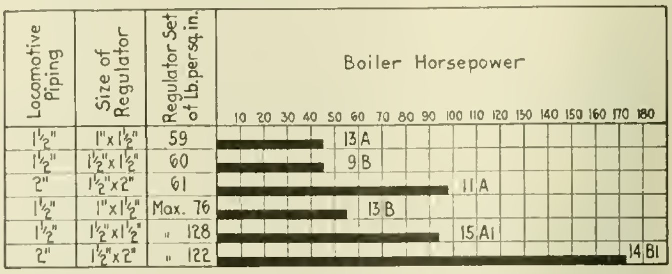


Chart IV.—Locomotive Equipment Capacities with Varying Adjustment of Regulators

The committee feel that the A. R. A. committee's specification calling for an available supply of 3,200 lb. of steam per hour, for the exclusive use of the steam train line, might well be used by us as a basis in determining maximum requirements, in which case, if the quantity of steam specified per hour cannot be obtained with low reducing valve adjustment, then the adjustment must be increased to suit.

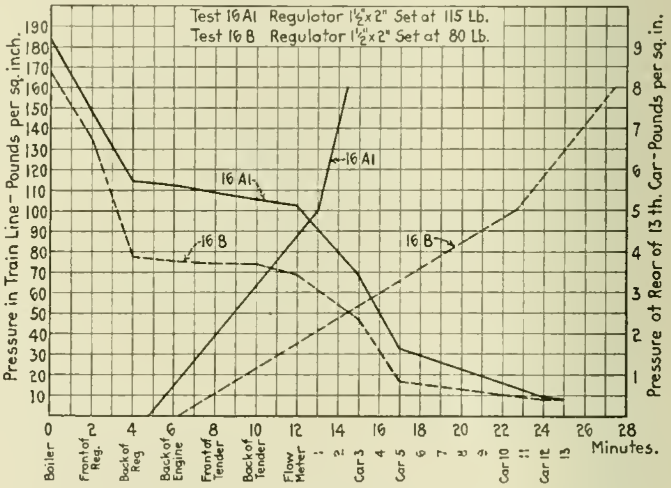


Chart V.—Pressure Drop in Train Line and Time to Obtain Pressure at Rear of 13 Cars. (Pressures at End of Test When 8 Lb. Obtained at Rear Car)

On the other hand, the disadvantages of carrying high steam train line pressure is, of course, thoroughly appreciated, and as a means of making a reduction possible, it is suggested that all known expedients be resorted to to insure that area of opening in all steam hose fittings, gaskets and end valves, be the equivalent of at least the opening of 1½ in. iron pipe or larger, thereby eliminating much of the friction now experienced.

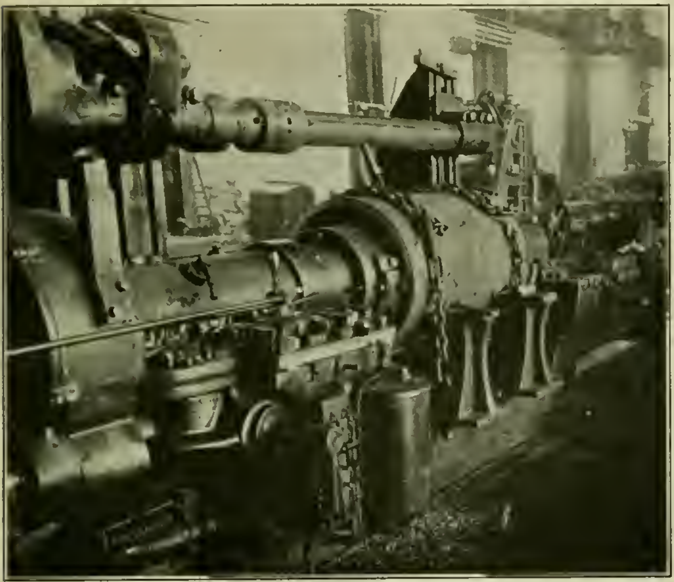
MELTING POINTS OF METALS	Deg. F.
Zinc	786.9
Lead	621.3
Aluminum (pure)	1,217.7
Silver	1,760.9
Iron, cast	1,920
Copper	1,981.4
Steel, mild	2,550
Nickel	2,646
Chromium	2,939
Vanadium	3,128
Tungsten	6,152

A Visit to a Prominent Mid-West Railroad Shop

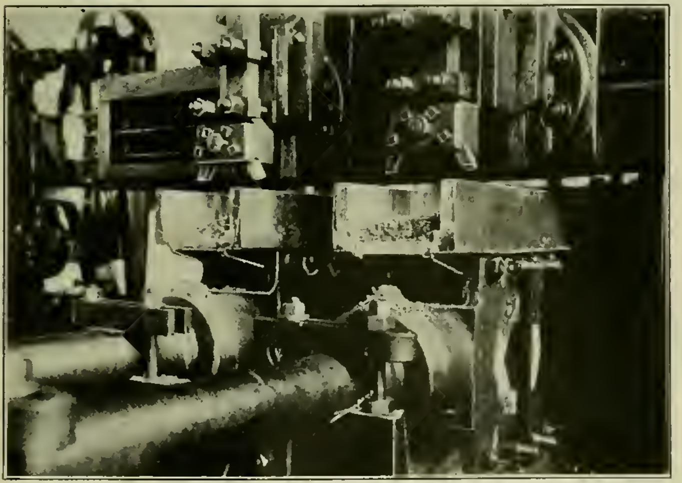
The Stranger Finds in the Various Departments at Silvis Some Novel Methods of Facilitating Work

By S. W. MULLINIX
Superintendent Shops, Chicago, Rock Island & Pacific

THERE are many operations in locomotive repair work that are performed with similar equipment and similar methods in practically all shops. There are other jobs that are done in a variety of ways and every shop has some interesting ways of doing work and some devices made in the shop that are labor savers and money savers. Such things are always of interest to visitors and those who have developed improved methods usually bring them to the attention of strangers going through the shops. With this in mind, it may be of interest to readers of the *Railway Mechanical Engineer* to describe some of the things that the visitor sees when he comes to Silvis shops.



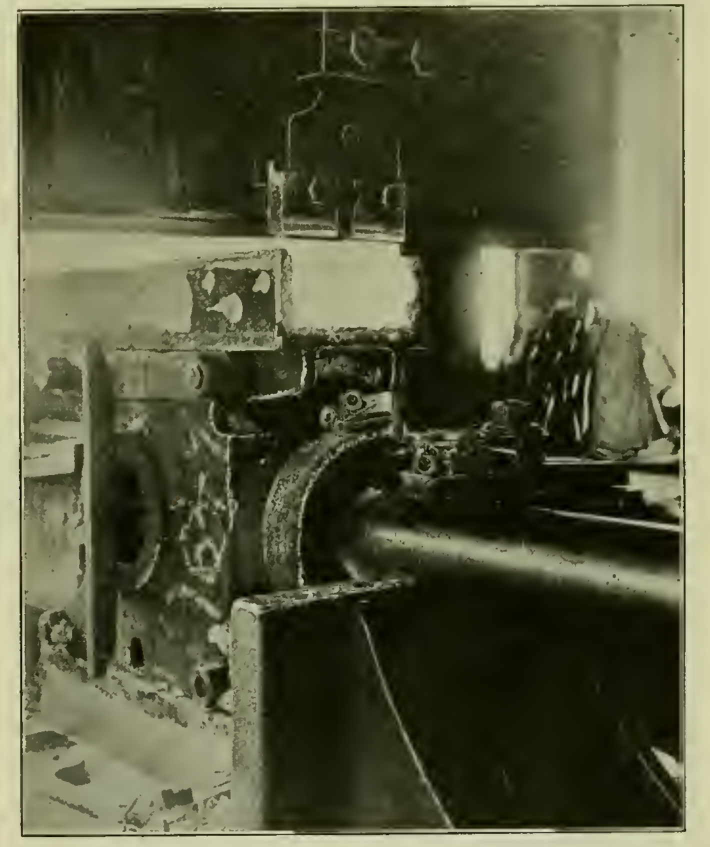
Chains are Readily Adjusted and are Convenient for Holding Work



Planing Two Crossheads at One Time with Adjustable Tool Holders

Let us assume that a party of men from other roads call at the office of the superintendent, whom they know, having met him at conventions. The superintendent takes it upon himself to show them through the plant, pointing out the things which in his mind would be most interesting to them.

On entering the machine shop the visitors are attracted by the number of boys operating machines; they ask if they are mechanics. The shop superintendent tells them no, but we are going to make mechanics out of them. We feel that any young man who starts in as an apprentice to learn a trade, if he behaves himself and has ordinary intelligence, is sure to advance; he cannot stand still, he must not go backward, so we must assist him in pushing forward.

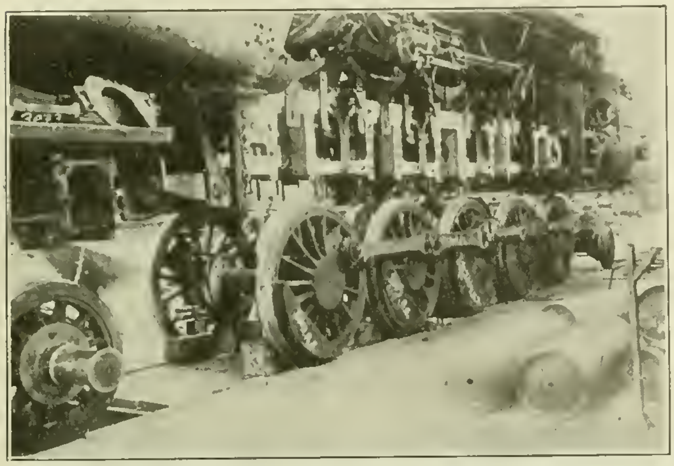


This Tool Has Reduced the Time of Planing Babbitted Crosshead Shoes by Half

When the party stopped at a cylinder boring machine, the operator was boring a cylinder bushing; it was held down by chains instead of by the old method of anchoring, which consisted of bolts, clamps and blocks. By doing away with these, the cylinder can be set up in half the time. The use of chains for holding parts being machined is not confined to cylinder bushings alone, but any work where they could be substituted in place of the old method.

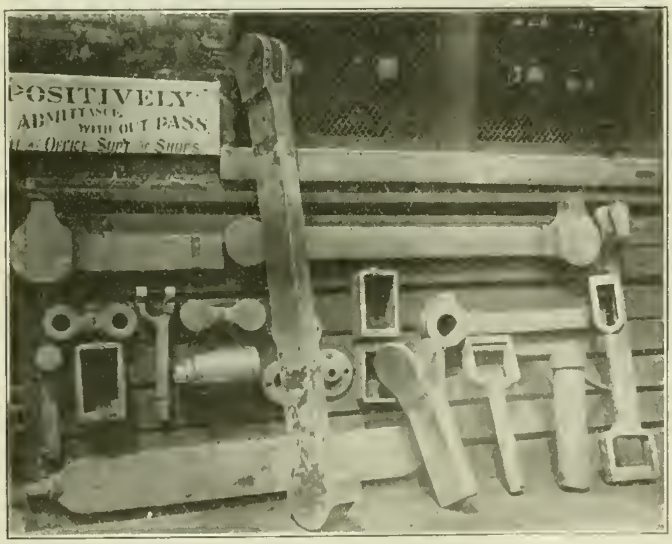
A little further on was a planer machining two crossheads at one time, using adjustable tool holders with four cutting tools instead of the old way using but one. The visitors quickly saw the advantage of this method and announced their intention of trying it in their own shops.

They next turned to a machine planing the guide fit of crossheads which had been babbitted. The superintendent explained the advantage this tool had over the old single tool with which it took one hour to do the job; it is now done in half the time. At one time it was the practice to use jigs for babbitting crossheads and not machining, but the results are not so satisfactory. The tool is adjustable and can be set to any width of guide.


Time is Saved by Applying Side Rods and Putting Binders in Place Before Wheeling

The visitors were then taken to the erecting shop where preparations were being made to wheel a locomotive. The superintendent explained the advantage in applying the side rods prior to wheeling, placing the binders on blocks under the driving boxes and wheeling the locomotive on the binders. The photograph shows this arrangement which saves many hours of hard work.

The party was very much interested in an electrically driven portable band saw that is used in fitting lagging to the boilers. This saw was built in the shop. Prior to the time it was built a common hand saw was used. A shop where a great deal of this work is done is not complete without one of these machines which can be built at a relatively small cost.



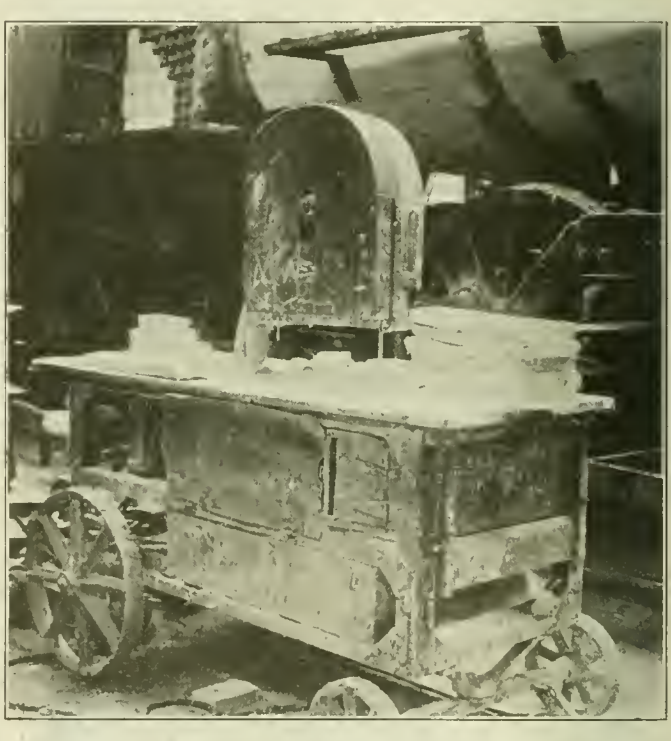
Forging Heavy and Intricate Parts Saves Both Labor and Material

The party next went through the forge shop where they were shown the piles of scrap that had been delivered by the store department to be worked up into standard forgings, which, when finished, would be delivered to the store for distribution. They were interested to see a collection of the most intricate parts produced on the forging machines as exhibited on the rack shown in the illustration.

Passing to the boiler shop, the first thing pointed out was a locomotive back end complete, the mud ring being riveted in by a 150-ton bull riveter. This is one of a number of extra back ends carried in stock to facilitate the handling of locomotives through the shop.

The shop superintendent called attention to the method of bushing enlarged staybolt holes in wrapper sheets, by applying soft steel bushings, which are made in the forging machine at the rate of 200 per hour and threaded by machines at the rate of 110 per hour.

The visitors examined with interest a machine that was making crank pin washers out of ½ in. scrap boiler plate. These parts are punched cold in two operations at the rate of 40 per hour. The special punch first punches out the center hole, 3½ in. in diameter. The second operation is to punch the outside of 6½ in. diameter.


A Band Saw for Cutting Lagging is a Great Time Saver

They were shown the method of renewing door, side and tube sheets in fireboxes, without renewing any rivets in the mud ring by cutting the side and door sheets off above the first row of staybolts and tube sheets below the holes for the tubes. These sheets are welded in, no rivets being used whatever.

After a visit to the store department and the scrap dock, the party returned to the office. Before taking their departure, they thanked the superintendent for the interest he had taken in showing them through the plant and expressed a desire to come again and bring others whom they knew would be interested. He assured them that he was always glad to welcome not only railroad men, but the general public as well for he felt that no employee should neglect an opportunity to reach out for business, and the shop men wished the public to know that they are just as keen to get their patronage as those in other departments.

Abrasive Paper and Cloth should never be stored in a damp place, as the glue absorbs moisture very quickly. This loosens the grain and causes it to rub off before it is dull.—*The Melting Pot.*

New Norfolk & Western 100-Ton Coal Cars

Tests to Determine Load on Springs Due to Irregular Track and Clearance for Curves

BY JOHN A. PILCHER
Mechanical Engineer, Norfolk & Western

(Continued from the May Issue)

A CAR body resting, as does this one, on four points of support, two on each truck, on rollers, allows for the vertical angling between the plane of the truck and plane of the car, in passing the sharp vertical curves of the tracks leading to the dumper. These four points of support also make it necessary that the car body be measurably flexible, in order that it may accommodate itself to the changes in the surface of the track, without undue stresses within itself, and without great differences in the load pressure on the four supporting points. This would not be possible with a closed top rigid car body. When such a rigid car body is used, a method of cross equalization on one end of the car must be introduced with a truck of this type.

Observations made on previously constructed large open-top cars, in connection with the adjustment of the side bearings, indicated there would be no difficulty in supporting such a car on four points. In fact, with the close adjustment of the side bearings, to prevent excessive rocking, the car body had, in a measure, to accommodate itself to the changes in the plane of the track, and has been doing this for a number of years without any apparent detriment.

Some experiments were conducted with the object of determining just to what extent such a car body could be warped out of its normal plane without detriment, and without excessive changes in the loading on the four points of support. The first experiment was on a flat-bottom gondola, and was made with both the light and loaded cars. Cars for the test were taken from the first group of 90-ton cars constructed, and known as Class GKa. Four groups of springs were prepared, of sufficient capacity to carry the loaded car body and accurately calibrated in a Riehle Testing Machine.

The car body was brought to a level plane, resting on the four groups of springs. The height of each group of springs was carefully measured and recorded. From previous calibration the corresponding loading in pounds was known. Liners of varying thickness were then placed under the car, on top of the spring at the diagonal corners, so as to bring the car body to a warped plane. The diagram in Fig. 1, with the accompanying table, gives the location of the groups of springs and tabulations showing the reading of the height of each spring and the corresponding load. In placing the liners of the thickness named in the table, two such were used, one each under opposite diagonal corners. The maximum warp in the car body for the light car was three inches

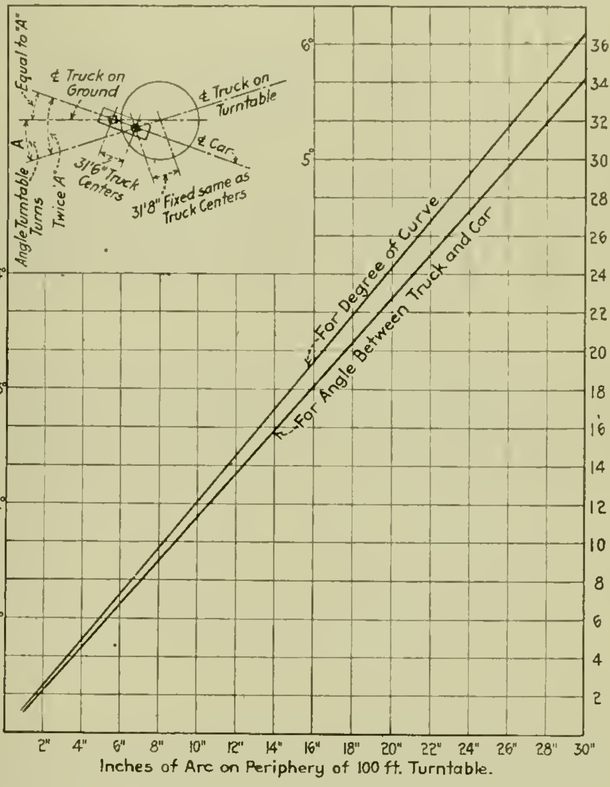
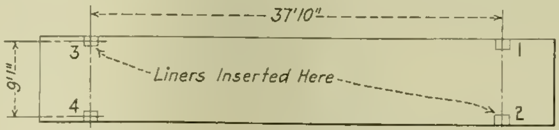


Chart for Determining Degree of Curve Over Which Car Will Pass

FIG. 1—TEST OF INEQUALITIES OF LOADS AT FOUR POINTS OF N. & W. 90-TON GONDOLA CARS, CLASS GKA, WITH DIFFERENT AMOUNTS OF WIND IN THE CAR BODY

FIGURES WERE OBTAINED BY SETTING CAR BODIES UPON FOUR GROUPS OF CALIBRATED SPRINGS, LEVELED TO A COMMON PLANE AND LOCATED UNDER THE ENDS OF BODY BOLSTERS. LINERS WERE THEN INSERTED UPON THE SPRING GROUPS OF DIAGONAL CORNERS AND THE HEIGHT OF GROUPS TAKEN

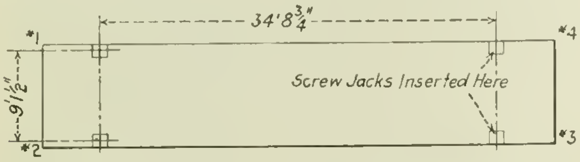


Weight of car used in test	Thickness of liners, inches	Height of springs at points, inches				Loads at the several points as deduced from the deflection of the springs, pounds				Total, pounds
		1	2	3	4	1	2	3	4	
Car empty with liners under diagonal corners 2 and 5. Empty car body, weight 32,400 lb.; body and trucks, 59,800 lb.	None	11 53/64	11 53/64	11 51/64	11 52/64	7,330	7,857	8,666	8,571	32,424
	½	11 53/64	11 53/64	11 52/64	11 53/64	7,330	7,857	8,000	8,461	31,648
	¾	11 53/64	11 52/64	11 52/64	11 53/64	7,330	8,571	8,000	8,461	32,362
	1¼	11 52/64	11 52/64	11 51/64	11 53/64	8,000	8,571	8,666	8,461	33,698
	1½	11 54/64	11 52/64	11 51/64	11 53/64	6,666	8,571	8,666	8,461	32,364
			Car loaded							
Loaded car body, weight of body and trucks, 237,100 lb. Body and lading, 209,700 lb.; body alone, 31,500 lb.	None	10 60/64	11 1/64	10 63/64	11 3/64	53,333	50,000	50.833	50,000	204,166
	½	11	11 2/64	10 58/64	11 4/64	50,000	49.167	55,000	49,167	203,334
	¾	11	10 61/64	10 58/64	11 4/64	50,000	53,333	55,000	49,167	207,500
	1¼	11 2/64	10 58/64	10 57/64	11 8/64	48,334	55,833	55,833	45,834	205,834
	¾	10 62/64	10 61/64	10 61/64	11 3/64	51,666	53,333	52,500	50,000	207,499
	½	10 61/64	10 63/64	10 61/64	11 2/64	52 500	51,666	52,500	50,833	207,499

off the plane of the other three points and on the loaded cars, 2½ in. It shows well for the accuracy of the measurements that the total loads, as shown from the spring readings, differ so little from the actual weight of the car body, both light and loaded. The figures, however, show for the light car a difference between the ends, represented by the numbers 1 and 2, and also the numbers 3 and 4, which does not exist. It is easily understood that the stiff, strong springs needed for use under the loaded car will not deflect much under the empty car. This accounts for this discrepancy.

The diagram and tabulations, Fig. 2, show the results of a test on a similar type of car, light, using springs of a capacity to suit the light car. The tabulations show some differences in the loadings, but when corner 3 is raised three inches, the difference, minimum to maximum, is not much more than when the car was level. The tabulations for the loaded car test, Fig. 1, show a difference, minimum to maximum loading, of 3,333 lb. when level. The difference, minimum to maximum, under the greatest wind given; viz., 2½ inches, is 9,999 lb., or less than 20 per cent of the load on one point. The maximum change of load at any one point during the test was 5,834 lb.; a little more than 10 per cent

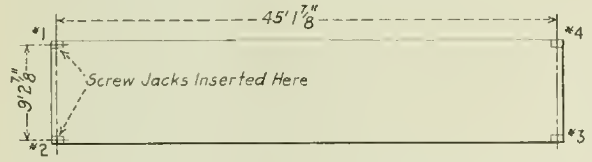
Fig. 2—Test of Inequalities of Loads at Four Points of N. & W. 90-Ton Gondola Car No. 101214, With Different Amounts of Wind in the Car Body. Figures Were Obtained by Setting Car Body Upon Four Groups of Calibrated Springs, Leveled to a Common Plane and Located Under the Jacking Blocks at Car Corners. A Small Screw Jack Was Then Placed on the Springs at the Corner to Be Raised, the Corner Raised 0.5 In. at a Time Until a Total of 3.0 In. Was Reached and the Readings of the Various Groups of Springs Taken



Heights corners were raised, inches	Height of springs at points, inches				Loads at the several points as deduced from the deflection of the springs, pounds				Total, pounds
	1	2	3	4	1	2	3	4	
	With Corner No. 4 Raised								
.0	12.945	12.795	12.90	12.83	7,600	8,225	7,880	8,480	32,185
0.5.....	12.975	12.775	12.92	12.805	7,425	8,330	7,770	8,625	32,150
1.0.....	13.00	12.745	12.95	12.785	7,290	8,525	7,600	8,780	32,145
1.5.....	13.025	12.72	12.97	12.76	7,125	8,675	7,490	8,880	32,170
2.0.....	13.055	12.70	12.99	12.735	6,990	8,800	7,375	9,025	32,190
2.5.....	13.08	12.67	13.02	12.71	6,780	8,990	7,180	9,180	32,130
3.0	13.11	12.645	13.04	12.685	6,590	9,140	7,070	9,340	32,140
	With Corner No. 3 Raised								
.0.....	12.95	12.80	12.91	12.82	7,570	8,180	7,830	8,530	32,110
0.5.....	12.92	12.82	12.88	12.84	7,740	8,070	8,000	8,425	32,235
1.0.....	12.89	12.85	12.86	12.87	7,920	7,890	8,120	8,260	32,190
1.5.....	12.86	12.88	12.83	12.89	8.085	7,720	8,275	8,130	32,210
2.0.....	12.83	12.92	12.81	12.92	8,270	7,470	8,390	7,970	32,100
2.5.....	12.80	12.95	12.79	12.94	8,430	7,300	8,510	7,850	32,090
3.0.....	12.77	12.97	12.77	12.96	8,610	7,180	8,620	7,720	32,130

Class of Car Used in Test—90-Ton N. & W., Gondola Car No. 101214, Light Weight 58,200 lb. Winding Test Results With First Corner 4 Raised, Then Corner 3

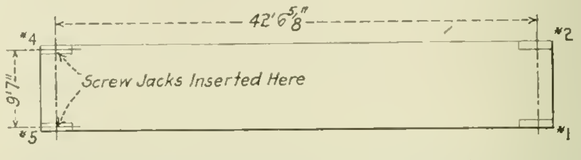
Fig. 3—Test of Inequalities of Loads at Four Points of N. & W. 90-Ton Hopper Car No. 70564, With Different Amounts of Wind in the Car Body. Figures Were Obtained by Setting Car Bodies Upon Four Groups of Calibrated Springs, Leveled to a Common Plane and Located Under the Jacking Blocks of Car Corners. A Small Screw Jack Was Then Placed on the Springs at the Corner to Be Raised, the Corner Raised 0.5 In. at a Time Until a Total of 3 In. Was Reached and the Readings of the Various Groups of Springs Taken



Heights corners were raised, inches	Height of springs at points, inches				Loads at the several points as deduced from the deflection of the springs, pounds				Total, pounds
	1	2	3	4	1	2	3	4	
	Hopper No. 70564, With Corner No. 2 Raised								
.0	12.74	12.935	12.705	12.925	8,780	7,375	9,025	7,940	33,120
0.5	12.76	12.915	12.73	12.90	8,630	7,500	8,860	8,080	33,070
1.0	12.80	12.88	12.765	12.86	8.430	7.720	8.640	8.315	33,105
1.5	12.82	12.86	12.795	12.835	8,320	7,850	8,475	8,450	33,095
2.0	12.85	12.83	12.83	12.81	8,150	8,010	8,275	8.600	33,035
2.5	12.87	12.81	12.845	12.78	8,030	8,160	8,190	8,770	33,150
3.0	12.885	12.79	12.87	12.75	7,940	8,250	8,060	8,930	33,180
	With Corner No. 1 Raised								
.0	12.72	12.965	12.70	12.94	8,920	7,220	9,050	7,860	33,050
0.5	12.69	12.99	12.67	12.96	9,100	7,060	9,250	7,740	33,150
1.0	12.66	13.02	12.64	12.99	9,300	6,875	9,450	7,570	33,195
1.5	12.63	13.04	12.605	13.02	9,490	6.700	9,675	7,375	33,240
2.0	12.60	13.07	12.575	13.06	9,690	6,550	9,875	7,120	33,235
2.5	12.58	13.10	12.55	13.09	9,725	6,360	10,040	6,925	33,050
3.0	12.55	13.12	12.53	13.12	10,020	6,230	10,170	6,730	33,150

Class of Car Used in Test—90-Ton N. & W. Hopper Car No. 70564, Light Weight 60,000 lb. Winding Test Results With Corners Nos. 1 and 2 Raised

Fig. 4—Test of Inequalities of Loads at Four Points of N. & W. 100-Ton Gondola Car No. 101750, With Different Amounts of Wind in the Car Body. Figures Were Obtained by Setting Car Body Upon Four Groups of Calibrated Springs, Leveled to a Common Plane and Located Under the Jacking Blocks at Car Corners. A Small Screw Jack Was Then Placed on the Springs at the Corner to Be Raised, the Corner Raised 0.5 In. at a Time Until a Total of 6 In. Was Reached and the Readings of the Various Groups of Springs Taken

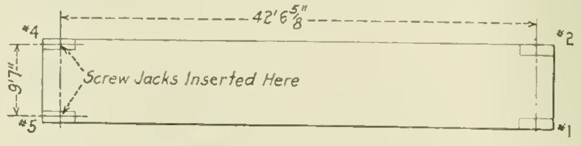


Readings With Jack Under Corner No. 5

Heights corners were raised, inches	Height of springs at points				Loads at the several points as deduced from the deflection of springs				Total, pounds
	Spring No. 1		Spring No. 2		Spring No. 4		Spring No. 5		
	Inches	Pounds	Inches	Pounds	Inches	Pounds	Inches	Pounds	
.0	12.820	8,325	13.090	6,420	12.885	8,170	13.095	6,725	29,640
0.5	12.860	8,080	13.050	6,680	12.900	8,080	13.060	6,945	29,785
1.0	12.875	8,000	13.020	6,840	12.935	7,880	13.035	7,100	29,820
1.5	12.900	7,860	12.990	7,065	12.960	7,740	13.000	7,320	29,985
2.0	12.935	7,660	12.950	7,305	12.995	7,530	12.985	7,400	29,895
2.5	12.950	7,575	12.945	7,330	13.005	7,480	12.960	7,545	29,930
3.0	12.970	7,460	12.905	7,575	13.030	7,315	12.935	7,680	30,030
3.5	13.000	7,280	12.875	7,745	13.060	7,120	12.910	7,830	29,975
4.0	13 030	7,100	12.855	7,870	13.085	6,960	12.890	7,940	29,870
4.5	13.050	6,975	12.835	7,980	13.110	6,800	12.865	8,080	29,835
5.0	13.080	6,780	12.805	8,160	13.130	6,665	12.845	8,190	29,795
5.5	13.100	6,660	12.780	8,310	13.150	6,545	12.825	8,300	29,815
6.0	13.125	6,500	12.755	8,960	13.170	6,415	12.815	8,365	30,240

Car Class GS, No. 101750. Weight of Body, 30,040 Lb. Trucks, 24,460 Lb. Total Weight, 54,500 Lb.

Fig. 5—Test of Inequalities of Loads at Four Points of N. & W. 100-Ton Gondola Car No. 101750, with Different Amounts of Wind in the Car Body. Figures Were Obtained by Setting Car Body Upon Four Groups of Calibrated Springs, Leveled to a Common Plane and Located Under the Jacking Blocks at Car Corners. A Small Screw Jack Was Then Placed on the Springs at the Corner to Be Raised. The Corner Raised Was First Raised to .5 In., Then to 1 In., and Then 1 In. at Time Until a Total of 4 In. Was Reached and the Readings of the Various Groups of Springs Taken



Readings With Jack Under Corner No. 4

Heights corners were raised, inches	Height of springs at points				Loads at the several points as deduced from the deflection of springs				Total, pounds
	Spring No. 1		Spring No. 2		Spring No. 4		Spring No. 5		
	Inches	Pounds	Inches	Pounds	Inches	Pounds	Inches	Pounds	
.0	12.755	8,575	13.130	6,165	12.840	8,430	13.135	6,540	29,710
0.5	12.750	8,715	13.135	6.130	12.800	8,650	13.150	6,380	29,875
1.0	12.715	8,945	13.160	5,975	12.776	8,790	13.180	6,190	29,900
2.0	12.606	9,690	13.215	5,625	12.725	9,080	13.230	5,880	30,275
3.0	12.595	9,725	13.270	5,265	12.685	9,330	13.275	5,610	29,930
4.0	12.500	10,340	13.335	4,845	12.625	9,690	13.340	5,180	30,055

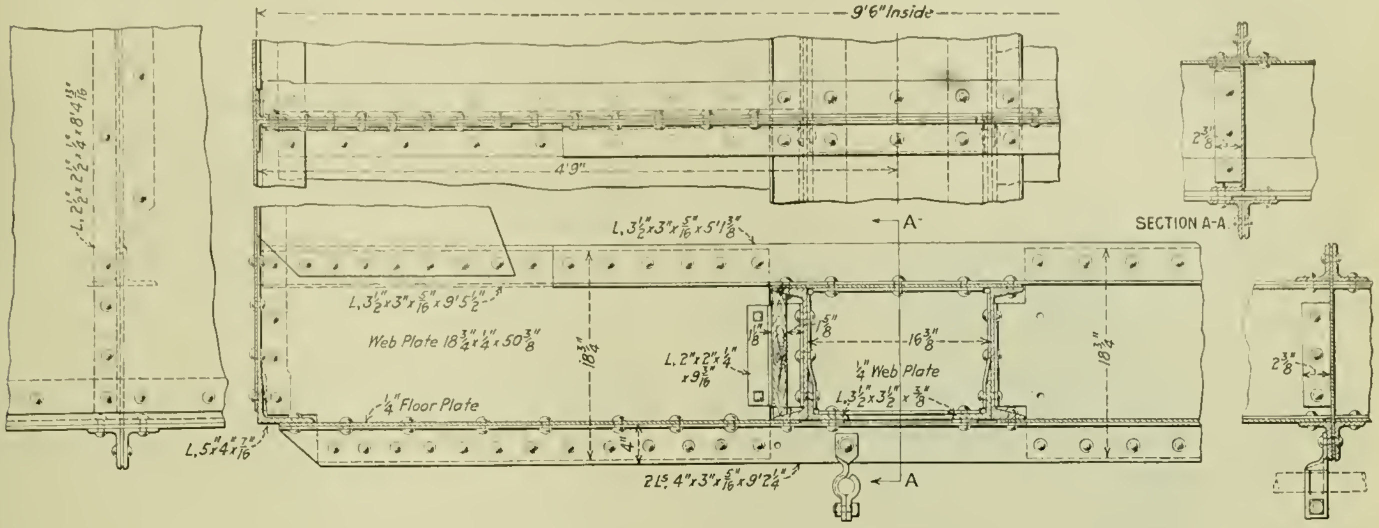
Car Class GS. No. 101750. Weight of Body, 30,040 Lb; Weight of Trucks, 24,460 Lb. Total Light Weight, 54,500 Lb.

Note—The test could not be finished on this corner, as the car began to creep due to the wind. A stiff breeze was blowing against this side.

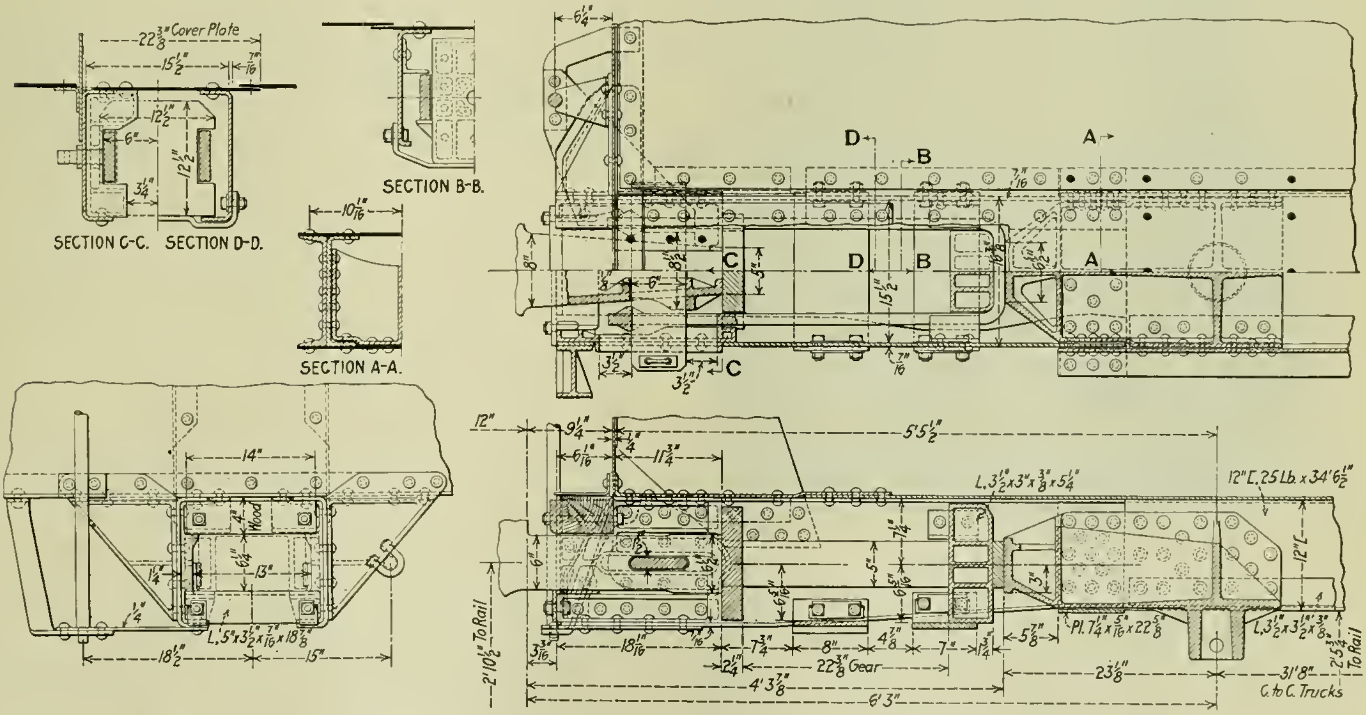
of the load on any one point. Two and one-half inches wind in a car, measured at the points shown, represents much more than will take care of any normal wind in the plane of the track.

A second and similar test was made on the light body of a 100-ton hopper car. Fig. 3 shows the relative location of the groups of springs with their measured heights and corresponding calibrated loads. In this test the observation of the change in level of the corner raised was taken with a surveyor's level, mounted at a suitable point for observation. First one corner was raised three inches, and then another at the same end of the car. Close observation of these readings led to the belief that this car body was erected with about 1½ or 2 in. warp out of the true plane. The readings are more uniform with the warp when corner No. 2 is raised than under any other condition. The readings indicate that the car is forced much farther from its original form when raising corner No. 1 three inches out of plane than when raising corner No. 2.

With the completion of the first new side-bearing supported car, an additional series of winding tests was conducted. Those shown in the table, Fig. 4, were made by lifting the corner marked 5; those shown in Fig. 5, by lifting the corner marked 4. These results are interesting, in that they show conclusively that this particular car was built with an initial warp or wind in the body of about 2½ or 3 in. This accounts for the wide differences shown in the loading on the four corners when the wind was put in the car by lifting corner No. 4 four inches out of the normal, which must have been 6½ or 7 in. distortion from the position in which the car body was riveted. This observation led to cautioning the builders to be careful in setting up the car for riveting together.



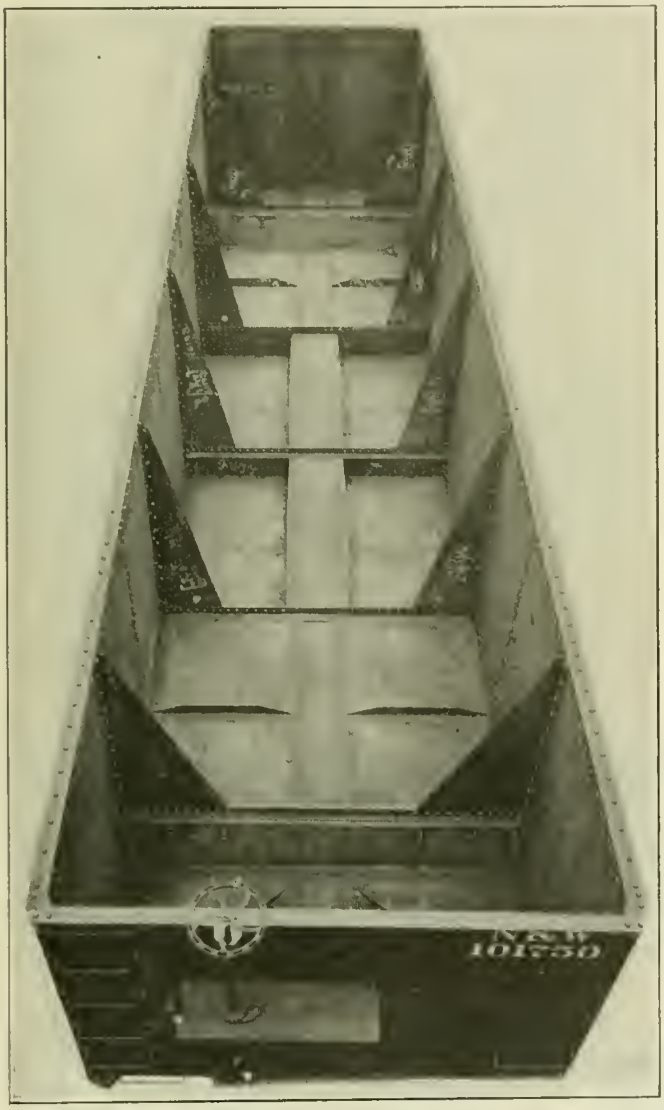
Details of the Center Diaphragm



Arrangement of Draft Gear With Farlow One-Key Draft Attachment

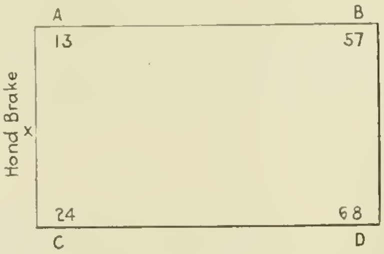
Further observations were made of the warping of the car when mounted on its own trucks. Fig. 6 gives the diagram and tabular figures showing the method and results of observations on both a loaded and empty car. An inspection of the photograph of the truck shows there are two groups of springs on each side of each truck. Remembering this the tabular figures in connection with the accompanying diagram can be readily understood. The readings in the columns are the heights of the different groups of springs, as measured. The measuring points on the truck did not admit of closer refinement in making the measurements. The results bear out the previous tests for winding on the car body, and show conclusively that an open-top car of this character can be carried on four points of support and conform itself to the changing plane of the track without undue stress and without marked change in relative loading on the four points. About 400 of these cars are now in regular service, and nothing has developed to indicate other than the deductions given above.

Before the first car was delivered for regular service, it was tested for clearance between the truck and car in curving up to curves of 35 degrees, using for this purpose a conveniently located turntable. One truck was placed in a fixed position on the turntable, with the other truck moving along the track as the table was turned to the extreme point the clearances between the truck and car would allow. By using the diagram, Fig. 9, and reading the movement of the turntable in inches at its circumference, the angular difference between car and truck, and corresponding curvature in track over which car could run without fouling, was readily determined.



Interior of the Car Body

Fig. 6—Spring Deflections of Sample 100-Ton Car, N. & W. 101750, the Result of Elevating the Truck Wheels at Different Corner Positions of the Car



Elevation of truck wheel out of normal plane	Spring heights in each nest (inches)							
	A		D		C		B	
	1	3	6	8	2	4	5	7
Empty Car Observed September 8, 1920								
Trucks in same plane....	8⅛	8⅛	8 1/16	8⅛	8 3/16	8 3/16	8	8 1/16
C ½ in. high; B ½ in. high; total 1 in........	8⅛	8¼	8⅛	8 3/16	8⅛	8 3/16	7 15/16	8
C 1 in. high; B 1 in. high; total ? in...............	8 5/16	8⅜	8 7/16	8½	8 1/16	8⅛	7⅞	8
A ½ in. high; D 1½ in. high; total 2 in.......	8	8 1/16	8	8	8¼	8¼	8	8 3/16
A 1 in. high; D 2 in. high; total 3 in.......	8	8	7 15/16	8	8¼	8 5/16	8 3/16	8¼
A 1½ in. high; D ?½ in. high; total 4 in.......	8	8	7 13/16	8	8½	8 7/16	8 5/16	8 7/16
D 1 in. high; total 1 in..	8 1/16	8⅛	8 1/16	8 1/16	8⅛	8 3/16	8	8 1/16
Loaded Car Observed September 23, 1920								
A 1 in. high; total 1 in..	7 7/16	7 7/16	7 3/32	7 9/32	7¼	7¼	7 3/32	7 3/32
C 1 in. high; total 1 in..	7⅝	7½	7¼	7 9/16	7¼	7¼	7 1/16	7⅛
A 3 in. high; total 3 in..	7 5/16	7 5/16	6 13/16	7 1/16	7½	7 7/16	7⅜	7 11/16
A 2 in. high; total 2 in..	7⅜	7 11/32	6 29/32	7 3/16	7 7/16	7 23/32	7¼	7 3/16

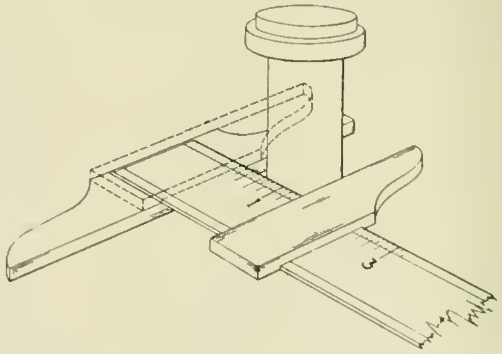
Note—In the loaded car results, the car was turned around but the same numbers and letters referred to are the same spring nests and corners as in the empty car test, as shown in the diagram.

A T-Square Attachment

BY C. NYE

A convenient attachment for T-squares is shown in the illustration. It consists of a sliding jaw, made of hard wood to the shape shown, and provided with a groove on the under side so that it slides freely but without vertical play on the T-square blade.

The use of this attachment is plainly indicated and it saves considerable time in measuring the diameters of models or small machine parts which are to be drawn. Graduations on the T-square blade are provided as small as desired and for any length. When not in use this attachment may be slid out of the way to the position indicated by the dotted lines, or removed altogether.



Drawing Facilitated by T-Square Attachment

For lapping hardened steel ordinary flour emery often leaves scratches caused by impurities. For the best results washed emery, such as opticians use, should be employed. Keep in a covered receptacle to exclude all dust.—*Abrasive Industry.*

Widening the Outlook of the Local Car Foreman*

Giving Supervisors At Outlying Points An Appreciation of the Business Aspect of Their Jobs

By L. K. SILLCOX
General Superintendent of Motive Power, Chicago, Milwaukee & St. Paul

If we were to take a map of the United States and endeavor to arrive at the number of car foremen scattered throughout this vast expanse of territory, we would be quickly impressed with the fact that many isolated points, far removed from large centers of population, have residing in their midst a local car foreman. The training which men receive in having charge of small outlying stations is probably the very best, if proper advantage is taken by them to make the most of their experiences and opportunities when so employed.

A man thus situated must of necessity be tremendously resourceful. He must know how to get along with the various officers and with his own men, working as one of them but, nevertheless, commanding their confidence and respect, besides being certain to deliver good service with little at hand to help. I wonder if we really take enough interest in these men, so as to give them encouragement to work for the future, and at the same time endeavor to regulate their training so that they can, without embarrassment to themselves, be prepared to take on added responsibilities.

It is unnecessary to enumerate the various duties required of these men, except to say that shifts are twenty-four hours long, seven days a week. Conditions govern a great deal in that some points are located at intersections with other roads and a complete working knowledge of interchange rules is vital; other stations are fitted up with slight wood and iron working facilities, etc., while occasional points have a wrecking outfit, and others handle both passenger and freight cars. Besides these obvious differences between various stations, we find a still greater divergence in the ability of various men to handle their work successfully, and while this is largely affected by reason of the personal ability of individuals, nevertheless if proper selection has been made in the first place, it is reasonable to believe that with adequate training and loyal support, most men should, through their own ambition as well as the assistance given by the higher supervisors, be in a position to advance and increase their responsibilities, both to their own business advantage and that of the railroad they serve.

Acting along this line, I am taking the liberty to bring to your notice a few items, appealing to me from personal experience, which would tend to round out a foreman's cycle of duty and make it possible for him to check honestly and impartially his own operations, and justify in his own mind whether progress has been experienced periodically. With labor and material so high, we must of course give careful study to the business side of the service so as to be sure that we can justify every expenditure made. No one is in a better position to do this than the local man who is actually employing the men to do the work and the material required for its completion; therefore, a study of the figures should be kept daily and measured against the output and actual service rendered to the railroad in facilitating the handling of transportation, which is the only commodity that any railroad has to sell.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY CO.

Distribution of Pay Roll for Month of __________ 192__

Station __________ Foreman __________

FIRST HALF

[illegible]	A	B	C	D	E	F	G	H	K	L	M	N	O	P	Q	R	S	T	U
Date	Freight Car Repairs	Passenger Car Repairs	Work Car Repairs	Shop Machinery Repairs	Passenger Car Retirements	Freight Car Retirements	Work Car Retirements	Locomotive Repairs	Locomotive Retirements	Dispatchers and Hostlers	Motor Car Repairs	Shop Orders	Coal Chutes	Transportation Expense	All Other Expenses	Total	MAN HOURS		
																	Straight Time	Overtime	Total
1																			
2																			
3																			
13																			
14																			
15																			
Monthly Rated Employes																			
Total First Half																			
								SECOND HALF											
16																			
17																			
18																			
30																			
31																			
Monthly Rated Employes																			
Total Second Half																			
[illegible]																			

Fig. 1—Form for Monthly Payroll Distribution Made Out at Each Repair Point

Payrolls

Regardless of whether a definite appropriation is given each month with which to operate a station, the local foreman ought, for his own benefit, to keep accurate record and separation of accounts so that he may be correctly informed daily and also measure the expense against the trend of business. Form 1795, which is used to very great advantage for this purpose, is shown in Fig. 1.

It is interesting to note from time to time just what ratio of overtime hours are expended relative to straight time man hours. The form shown in Fig. 2 is used for that purpose.

Inspection

The cost of inspection per car handled ought to be an index of yard service and any car foreman having to do with

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* Abstract of a paper presented before the Car Foremen's Association of Chicago, April 11, 1921.

operating officers will assist himself greatly through the keeping of a statement somewhat as suggested below:

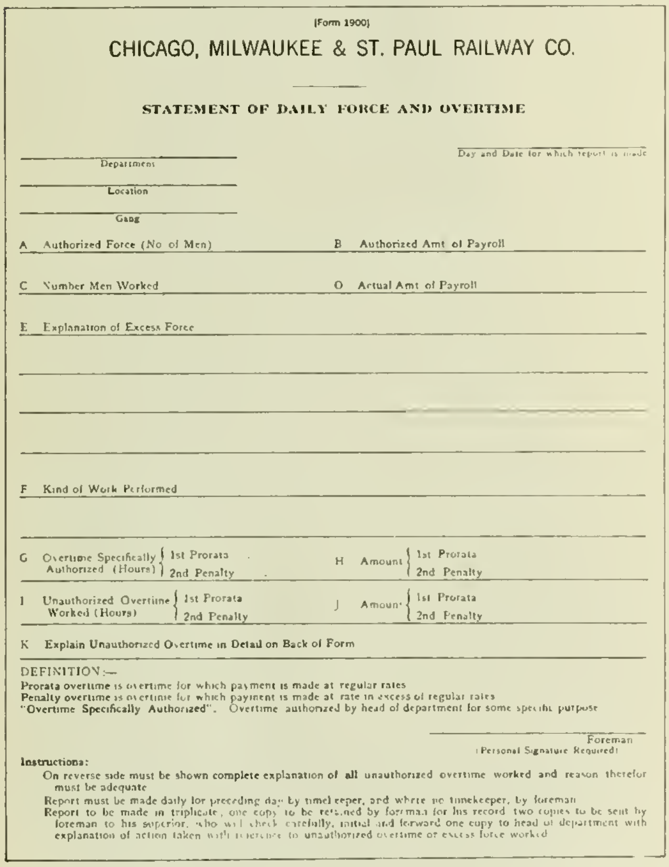
Cost of Train Yard Inspection

Date	No. of Cars Handled Through Yard	Total Labor	Cost Per Car

In addition to this, it is well to know exactly the time required to handle each train so that no question of delay may arise which cannot be accurately checked; it should also be established just what men were responsible for the particular work done on the equipment. Besides, a system can be arranged for whereby train crews will report the difficulty which they may have had with cars before arrival at destination. This can most easily be followed up by using the inspection form shown in Fig. 3.

Repairs

Care should be employed to see that no cars are switched to repair tracks which can be handled in train yards under blue flag protection. In order to avoid delay to equipment as well as further damage on this account and the cost of switching, it is generally a good plan for the man in charge to cover his entire point, including train yards, repair tracks, loading and industry platforms, interchange stations, etc., each morning or periodically each day so that a systematic method of procedure can be followed out.



(Form 1900)

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY CO.

STATEMENT OF DAILY FORCE AND OVERTIME

Department

Location

Gang

Day and Date for which report is made

A Authorized Force (No of Men)

B Authorized Amt of Payroll

C Number Men Worked

O Actual Amt of Payroll

E Explanation of Excess Force

F Kind of Work Performed

G Overtime Specifically Authorized (Hours) { 1st Prorata / 2nd Penalty

H Amount { 1st Prorata / 2nd Penalty

I Unauthorized Overtime Worked (Hours) { 1st Prorata / 2nd Penalty

J Amount { 1st Prorata / 2nd Penalty

K Explain Unauthorized Overtime in Detail on Back of Form

DEFINITION:—
Prorata overtime is overtime for which payment is made at regular rates
Penalty overtime is overtime for which payment is made at rate in excess of regular rates
"Overtime Specifically Authorized". Overtime authorized by head of department for some specific purpose

Foreman
(Personal Signature Required)

Instructions:

On reverse side must be shown complete explanation of all unauthorized overtime worked and reason therefor must be adequate

Report must be made daily for preceding day by timekeeper, and where no timekeeper, by foreman

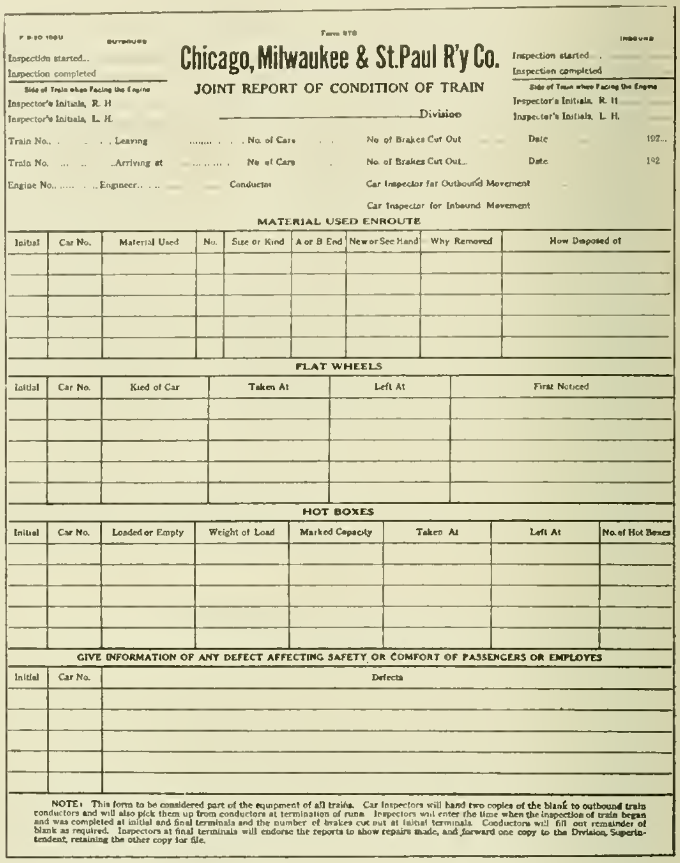
Report to be made in triplicate, one copy to be retained by foreman for his record two copies to be sent by foreman to his superior, who will check carefully, initial and forward one copy to head of department with explanation of action taken with reference to unauthorized overtime or excess force worked

Fig. 2—Form Used to Keep a Daily Check on Overtime. In a Year Overtime was Reduced From 16 Per Cent to 6 Per Cent of the Total Payroll

Set Outs and Break In Twos

Train movements are more or less delayed by reason of the setting out of cars, mostly for defects such as hot boxes, break beams down, couplers dropped out, etc. In certain localities very few such cases occur, while in other, and perhaps adjoining territories, the number of such embarrassments is large, a condition which cannot be justified under any circumstances. There seems to be a reason for differences of this sort in service and there is no question but that there will be an occasional failure which could not have been prevented. These, however, are rare when cars are given proper inspection before being allowed to proceed on the line. In order to keep a suitable record, tabulations are maintained as indicated on the forms shown herewith. One is a record of draw bar failures and the other that of hot boxes encountered between terminals.

If local men watch such reports closely and take action in connection with cars which, having left their terminal, are set out on account of mechanical defects and make a thorough investigation with a view of correcting the difficulty and preventing a recurrence, much good to the service will be experienced. Any foreman, who will not take the trouble to see these reports and is not close to his train yard organization, is bound to give poor service to the transportation department. It should not be taken for granted that it is impossible to run a train without setting out a bad order or



F 8-20 1000 OUTBOUND

Inspection started..

Inspection completed

Side of Train when Facing the Engine

Inspector's Initials, R. H

Inspector's Initials, L. H.

Form 978

Chicago, Milwaukee & St. Paul R'y Co.

JOINT REPORT OF CONDITION OF TRAIN

Division

INBOUND

Inspection started

Inspection completed

Side of Train when Facing the Engine

Inspector's Initials, R. H

Inspector's Initials, L. H.

Train No. ... Leaving ... No. of Cars ... No. of Brakes Cut Out ... Date ... 192..

Train No. ... Arriving at ... No. of Cars ... No. of Brakes Cut Out ... Date ... 192

Engine No. ... Engineer ... Conductor ... Car Inspector for Outbound Movement

Car Inspector for Inbound Movement

MATERIAL USED ENROUTE

Initial	Car No.	Material Used	No.	Size or Kind	A or B End	New or Sec Hand	Why Removed	How Disposed of

FLAT WHEELS

Initial	Car No.	Kind of Car	Taken At	Left At	First Noticed

HOT BOXES

Initial	Car No.	Loaded or Empty	Weight of Load	Marked Capacity	Taken At	Left At	No. of Hot Boxes

GIVE INFORMATION OF ANY DEFECT AFFECTING SAFETY OR COMFORT OF PASSENGERS OR EMPLOYES

Initial	Car No.	Defects

NOTE: This form to be considered part of the equipment of all trains. Car Inspectors will hand two copies of the blank to outbound train conductors and will also pick them up from conductors at termination of runs. Inspectors will enter the time when the inspection of train began and was completed at initial and final terminals and the number of brakes cut out at initial terminals. Conductors will fill out remainder of blank as required. Inspectors at final terminals will endorse the reports to show repairs made, and forward one copy to the Division Superintendent, retaining the other copy for file.

Fig. 3—An Inspection Report Which Clearly Defines the Responsibility of Train Service and Car Department Employees for Condition of Equipment in Trains

Record of Drawbar Failures Between Terminals and Comparison of Ranking of Engineers as to Car Miles Per Failure

Period—One Month

Territory—One Operating Division

Comparison to be made upon Drawbar Failure per car miles accumulated on the Division for one month.

Rank	Engineer's Name	Draw Bar Failures	Number of Cars Hauled	Total Car Miles Per Engineer	Car Miles Per Draw Bar Failure
Totals......					

Record of Cars Set Out on Account of Hot Boxes Between Terminals and Comparison of Ranking of Conductors Per Car Set Out

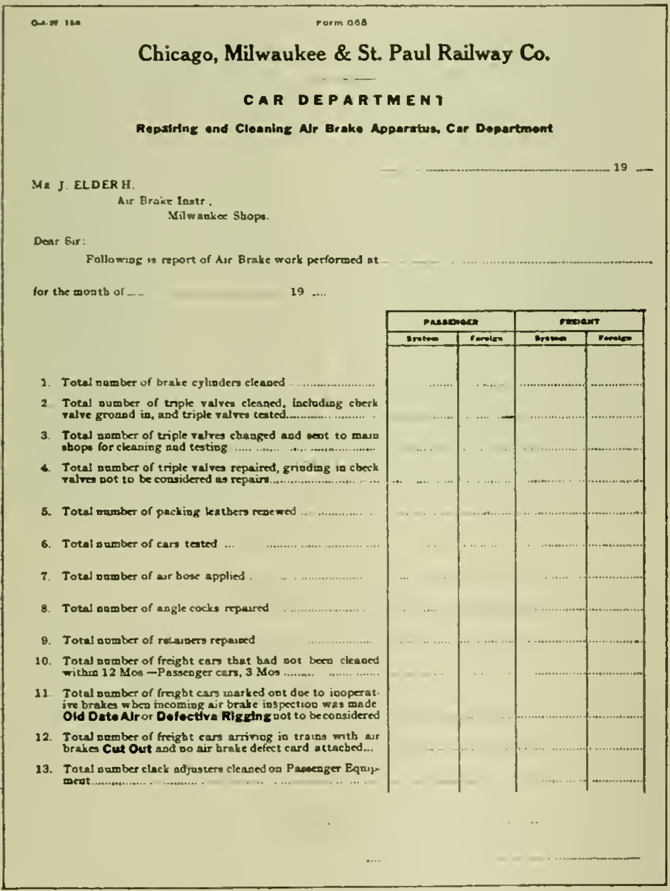
Period—One Month

Territory—One Operating Division

Rank	Conductor's Name	Car Set Out Acct. of Hot Box	Number of Cars Hauled	Car Miles Per Conductor	Car Miles Per Hot Box Set Out
Totals......					

two or without having a wreck once in a while, and a great deal of this difficulty can be saved by giving equipment more careful inspection before trains leave terminal yards.

In order to safeguard the service a careful outbound inspection ought to be insisted on and repairs made where necessary. It seems needless to refer to just what should be done in order to guarantee proper protection, aside from mentioning that brake rigging, trucks, and draft gear should be carefully gone over. Cars showing signs of derailment or rough handling should be critically examined. Lost cotter keys ought to be replaced in order to safeguard pins from working out and allowing brakes to drop down; brake beams should be most carefully looked over in connection with all of their attachments; center plates should be checked up to see if they register properly, that the car is not off center or the center pin broken; shattered journal boxes, broken bolsters and side frames, also journal boxes having packing or even the bearing missing, should be constantly safeguarded in order to avoid derailment. It should be kept in mind that draft gears receive most of their damage in switching and each should be inspected after being placed in trains because draft bolts will probably be found broken, follower plates out of place, draft timbers spread, split, or shattered, carrier irons or coupler tie straps down, yoke rivets or yoke broken and coupler, knuckle, lock or knuckle pin broken. Such failures happen daily through setting equipment out en route. Where hot boxes do occur requiring the setting out of a car, report always ought to be made of this fact in order to prevent the same car being taken out by some other crew unawares, resulting in a failed journal and subsequent derailment.



O-4-W 184 Form 068

Chicago, Milwaukee & St. Paul Railway Co.

CAR DEPARTMENT

Repairing and Cleaning Air Brake Apparatus, Car Department

19

Mr. J. ELDER H.
Air Brake Instr.,
Milwaukee Shops.

Dear Sir:

Following is report of Air Brake work performed at

for the month of 19

	PASSENGER		FREIGHT	
	System	Foreign	System	Foreign
1. Total number of brake cylinders cleaned				
2. Total number of triple valves cleaned, including check valve ground in, and triple valves tested				
3. Total number of triple valves changed and sent to main shops for cleaning and testing				
4. Total number of triple valves repaired, grinding in check valves not to be considered as repairs				
5. Total number of packing leathers renewed				
6. Total number of cars tested				
7. Total number of air hose applied				
8. Total number of angle cocks repaired				
9. Total number of retainers repaired				
10. Total number of freight cars that had not been cleaned within 12 Mos.—Passenger cars, 3 Mos.				
11. Total number of freight cars marked out due to inoperative brakes when incoming air brake inspection was made **Old Date Air** or **Defective Rigging** not to be considered				
12. Total number of freight cars arriving in trains with air brakes **Cut Out** and no air brake defect card attached				
13. Total number slack adjusters cleaned on Passenger Equipment				

Fig. 4—Keeping Track of Air Brake Conditions and the Amount of Brake Work Performed

It is suggested that wheels be changed on empty cars finding their way into loading territory and replacements of bearings and packing be made as much in advance of loading as possible so that the journals can be broken in and avoid heating under the return loaded movement.

Transferring and Adjusting of Loads

The handling of equipment requiring adjustment of loads or complete transferring is a most important matter, especially at this time when business is not the best. Every moment of delay accorded a car means just that much dissatisfaction on the part of a patron so that good judgment and prompt action is necessary to guard against any chances being taken with a shipment destined to a distant point which might involve its subsequent damage.

Safety Appliances

This is a matter requiring constant vigilance, proper inspection, and a careful check daily by the man in charge. If this simple rule is lived up to, very little embarrassment will result, it being understood that the local man has a thorough knowledge and understanding of government requirements.

Air Brakes

Aside from the general inspection, and maintenance of air brakes commonly known to all, the amount of work done in this branch of the service should be carefully recorded by the local man to ascertain, if possible, whether he is doing his share, considering the number of cars handled by him, and in order to maintain the required cycle of cleaning, testing, etc. A form showing just how such work can be kept track of satisfactorily is shown in Fig. 4.

Material

A certain ratio or percentage of labor to material ought to be maintained at any point where there is a normal and fixed operation. Nobody can check this up better than the local man in charge, and aside from looking ahead to see that a suitable supply of required items is kept in stock, proper effort ought to be made to see that an excessive stock is not maintained. Proper credits should also be received for scrap which has been recovered. This can be taken care of on a simple form, which is in effect a request on the division storekeeper for credit, on which the foreman lists the material and states to what account credit should be allowed. Every usable item possible ought to be reclaimed and conserved within the means of the facilities provided. This will, of course, require the local man's hearty interest and earnest co-operation so as to avoid waste in every possible form.

Selecting and Preparing Cars for Loading

No greater responsibility is placed upon a local foreman than that of seeing to it that every car loaded within his radius of service is made fit and suitable for the commodity it is to carry, both as to condition of the door fixtures, doors, roofs and all the superstructure, as well as the running gear, brake rigging, etc. This should be a matter of daily personal check by him so that the loss and damage account can be minimized and the service protected to a maximum degree. Were each man at every outlying station to do his full share in this direction, it is certain that the number of loaded cars that now show up in unfit condition, would be reduced and a proper selection made for each grade of freight offered.

The best advice for every local car foreman is the old and simple rule of getting knowledge and understanding, and determining to make the most possible out of the future by doing the best that is in his power. There are no new receipts for success in life. A good aim, deligence in learning every detail of the business, honest, hard work and determination to succeed will win out every time unless some exceptional accident or misfortune interferes. Many opportunities come to every man. It depends upon himself and upon what he desires to make of himself, what he makes of opportunity and what it makes of him. Each man must stand by his record. If he has been able to do any good, he should be glad. If he has made any mistakes, they ought not to have been intentional. If he has injured anyone, he should be sorry.

Tact stands above all else. It is so easy to recognize, yet so hard to acquire. The first essential is loyalty, otherwise known as system, organization, or any one of a dozen different things. A foreman with tact will have the loyalty of his entire force. At any station, even though it may be poorly equipped mechanically, where the human equipment is in good order we find, in every case, that the unknown quantity is always within this same human element and the equation must be solved by the foreman to find its value. The degree of effectiveness attained depends upon the ability of the man in charge.

Discussion

Several of those who took part in the discussion expressed some doubt as to the practicability of some of the forms suggested by Mr. Sillcox on the ground that the foreman at an outlying point would not have sufficient clerical help to relieve him of doing the work himself, and that this would interfere with his more important duties as a supervisor. It was pointed out, however, that in the absence of such forms the foreman was required to report a considerable part of the same information by letter and that the form in which information was presented in this way was such that a large amount of correspondence was usually required before such reports could be interpreted in a satisfactory manner. On the other hand, the forms are specific and are easily filled out. Mr. Sillcox referred to the fact that before they were put into effect on the Chicago, Milwaukee & St. Paul, the foremen were freely consulted and had offered no objection to their use. In commenting particularly on the use of the form shown in Fig. 2, he stated that by careful supervision, overtime had been reduced in a year from 16 per cent to 6 per cent of the total payroll.

Several of those who took part in the discussion expressed the opinion that such records as outlined by Mr. Sillcox would be of great value in giving these men a better grasp of the business side of their work.

The fact was also brought out that the inspection form, shown in Fig. 3, has greatly reduced the friction between the transportation department and the car department in question such as those involving terminal delays. The inspection form, which must be delivered to the conductor before the train leaves a terminal and then turned over to the inspector on arrival, provides a clean record which has enabled controversies to be settled on the ground.

The information reported by the local foreman on these forms is compiled into general statements for the system and each car foreman receives a copy of the monthly bulletin in which the results of all operations of the department are published, thus tying up his own results with those of the system as a whole.

Welding Cylinders with Tobin Bronze

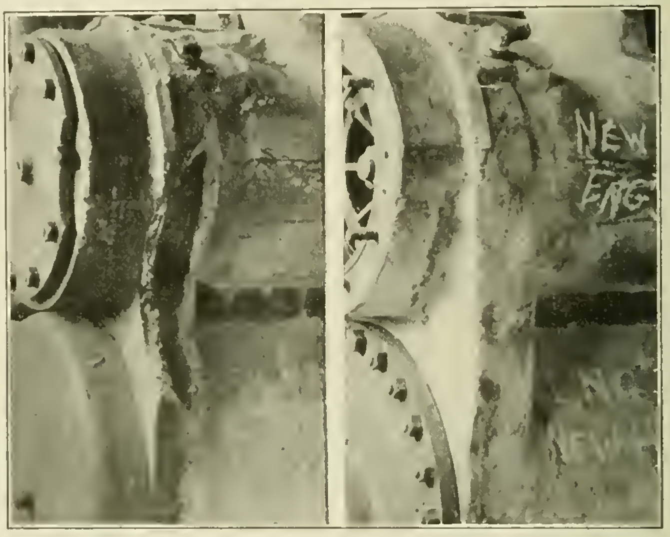
BY JOSEPH T. PAIGHT

General Oxweld Inspector, New York, New Haven & Hartford, New Haven, Conn.

A locomotive was received at a repair shop recently with the left cylinder broken as shown in the illustration. It was decided to make the repair by welding, using Tobin bronze as a flux to hold the broken parts in place and fill in where any parts were missing.

In preparation for the weld, the piston and main valves were removed, the exhaust nozzle plugged up and two circular discs of sheet iron cut out just large enough to fit inside the cylinder and valve chamber studs. The edges of the broken cylinder and the broken parts were chamfered to an angle of 45 deg., being drilled and tapped on the inside to receive ½-in. tap bolts. These short tap bolts were screwed in to within ¼ in. of the heads and greatly strengthened the weld as finally made. A 1/16 in. chip, 1¼ in. wide, was also taken externally all around the break, so there would be no difficulty in tinning the casting. The broken pieces were then welded together and set in place, being tacked to the cylinder at four places.

With these initial preparations, an oil torch was applied first in the big cylinder and then in the valve chamber, burning slowly for about 10 min. in each. The circular sheet iron discs were applied, being held in place by four nuts, and the torch inserted through the back head of the cylinder, burning slowly. In about an hour's time the cylinder was too hot to touch and the flame was then reduced, being allowed to burn slowly while the weld was made. The weld across the bottom was completed by one man and two were used to weld the two sides at the same time until they had welded nearly to the top. The weld was completed by one operator as shown in the right section of the illustration and covered up with asbestos, the torch being removed from the back head and the hole plugged up. In the morning the cylinder was cool and when the motion work had been reapplied, the locomotive was returned to service.



Cylinder Before and After Welding with Tobin Bronze

In welding cast iron with bronze, the method is to heat a little place on the casting about 1½ in. long and put a thin coating of bronze over it similar to the method of tinning parts before soldering them. The casting is tinned from 1 to 1½ in. ahead of the weld, and by using this method, a good strong weld is obtained.

About 75 lb. of Tobin bronze was used on this welding job and the time required was eight hours. This was considerably less than would have been required by the older method of welding due to several causes. It was not necessary to build a firebrick oven around the entire cylinder and then tear it down again; since the temperature was low, only a short time was required to pre-heat and finally cool the cylinder; the cylinder was not distorted so the bushings did not need to be rebored; in addition, the actual welding with bronze is more rapid than with cast iron rods. That cylinders can be satisfactorily welded with Tobin bronze is attested by the fact that several, repaired by this method, have been in service for seven months, giving no trouble.

Modifications in Rules Proposed by C. I. C. I. & C. F. A.

Load Limits; Billing Where Wrong Material Is Applied; Revision of Prices for Labor and Material

THE first part of the discussion of the Rules of Interchange which took place at the meeting of the Executive Committee of the Chief Interchange Car Inspectors' and Car Foremen's Association on March 3 and 4 was published in the April and May issues of the *Railway Mechanical Engineer*. The continuation of the recommendations pertaining to changes in the freight car rules and the discussion are given below.

Rule 84

F. H. Hanson: Referring to Rule 84, I move that the words "Cut journals" be eliminated from this rule.

The motion was seconded and carried.

M. E. Fitzgerald: I make a motion also to eliminate "axles bent" as that is taken care of in Rule 32 and Rule 43.

The motion was seconded and carried.

Rule 86

M. E. Fitzgerald: There is conflict between Rule 86, page 90, and the loading rules. You have a total weight on rail in Column A for cars of 60,000 lb. and 40,000 lb. capacity. The loading rules advise that those cars may not be loaded in excess of 10 per cent of the stenciled capacity, and the 95,000 lb. for the 60,000 lb. capacity and the 66,000 lb. for the 40,000 lb. capacity, shown in Column A, Rule 86, should be changed, properly correcting the rule so that there is no conflict with loading rules.

A. Herbster (N. Y. C.): Does not Rule 2, page 12, second paragraph, take care of that?

M. E. Fitzgerald: Yes, under the loading rules you could put 66,000 lb. in the car and, taking that together with the stenciled light weight, it will exceed 95,000 lb. in some cases. It is confusing to the car inspectors, station agents and others.

F. W. Trapnell: We had that up with Mr. Hawthorne for an interpretation and he said it had been referred to the Committee on Trucks for them to give us a decision on it. He said that as soon as they rendered a decision they would furnish it.

Chairman Gainey: I do not believe you will get that changed. From an engineering standpoint the eight journals are figured to carry so much, and I do not believe they will give you over 95,000 lb.

F. W. Trapnell: The loading rules permit us to load those two kinds of cars ten per cent above marked capacity. That is all we are asking, just an interpretation on the 40,000 lb. and 60,000 lb. capacity cars.

M. E. Fitzgerald: Paragraph (c), Rule 2, applies to cars of 80,000 lb. capacity and over, eliminating reference to the 60,000 lb. and 40,000 lb. cars, and making the maximum shown in Column A, Rule 86, apply only to the heavier cars.

E. H. Mattingley: A great many 60,000 lb. capacity cars are running around the country today that, by loading them according to the loading rules, ten per cent over their marked capacity, will weigh more than 95,000 lb. at the rail. The shipper will say, "I can load ten per cent over the marked capacity." If that car has a light weight of 40,000 lb., it is overloaded. What are you going to do? Is it transferable in interchange? According to loading rules, it is not; according to Rule 86, it is.

Mr. Pellien: It seems to me a recommendation to increase the limits on these two capacity cars will take care of that. Permit them to load ten per cent above capacity by increasing the limits of wear sufficiently to take care of that excess light weight. The total weight on rail of 95,000 lb. is based on the limits of wear on the 60,000 lb. capacity car of 3¾ in. My idea is that by increasing that to, say, 3⅞ in., or something of that sort, it would place you in a position to load that car to the ten per cent above the marked capacity.

A. Kipp (N. Y. O. & W.): We have some refrigerator cars running as high as 49,500 lb. They haven't any heavier axle than the car that has a light weight of 33,000 lb. There should be some limit of load on the rail, just the same as there is in the others.

M. E. Fitzgerald: Load limit on the rail, shown in Rule 86, takes into consideration a factor of safety provided in all axles. I do not approve of increasing that to take care of further added weight to the car due to draft arms, sills or any other appliances; but our agents and car inspectors responsible for the loading of the cars are placed at a decided disadvantage by the conflict. There is an error in one or the other. I move that we refer the matter to the Arbitration Committee to correct the loading rules, even though we are not discussing them, to bring about harmony in these rules.

The motion was seconded and carried.

Rule 88

M. E. Fitzgerald: Rule 88, referring to handling line using material from its own stock instead of ordering material from car owners, makes the repairing line responsible only for the labor required to correct improper repairs. In the event you apply non-standard lug castings to a foreign car you naturally are forced to wrong frame the draft timbers, possibly the draft sills and end sills. Owners contend that those particular items, the sills, draft timbers and end sills should be furnished from your stock. I contend that the authority granted to put on lugs of other make carries the authority with it to make the necessary wrong repairs to the other items. I think that the rule should be so written because it is not clear.

C. M. Hitch: Mr. Fitzgerald is correct as to the wrong framing of center sills and end sills due to the formation of the draft arms; this is done frequently and I believe his point is well taken.

Chairman Gainey: There is no occasion to frame the draft sills and end sills wrong for any attachment.

A. S. Sternberg: How about the car where the lugs are attached to the center sills?

Chairman Gainey: Frame the draft timbers right for the lugs and bore the castings to fit the sills. In no case will I frame draw sills or end sills wrong. When it comes to draft timbers, I agree with you.

A. Kipp: We have dozens of box cars that we had equipped with draft arms and they have come back home with the wrong framed draft sills, wrong draft timbers and wrong end sills.

M. E. Fitzgerald: It is absurd to give the owner the right to bill you for labor and material when the rules give you a right to put in lugs you may have in your stock. At some points on any railroad you work where there are no facilities to drill the lug castings or chip them out to conform with the original construction of the car. It is not done and even though you can do it, it is not practical.

I move that we recommend that Rule 88 be re-written so that it will convey to us the fact that repairing lines using material from their own stock and forced to wrong frame timbers or other material which they should carry in their stock and are supposed to furnish under this rule, are relieved of responsibility as to material when correction of those wrong repairs are made.

The motion was seconded.

P. M. Kilroy (St. Louis-South Western): The rule as it is written carries his point with it. If he applies the defect card at the time that he makes the improper repairs, he fully complies with the rule and it carries with it everything that he is asking for.

A. Herbster: Irrespective of that, a number of roads are coming back for wrong framed draft timbers, for center sill splices and end sills, claiming this material is carried by every railroad, and that you are applying only the lug casting, which you do not have standard for the foreign car.

P. M. Kilroy: Did you apply your defect card in accordance with the rule?

A. Herbster: For labor only.

M. E. Fitzgerald: You have a rule that tells you certain material you must carry in your own stock. Any deviation from that is construed by the rules as wrong repairs. There is a conflict in the rules.

A. S. Sternberg: I move as an amendment, that there be a committee appointed to frame up a rule in accordance with Mr. Fitzgerald's motion and present it at tomorrow's meeting.

The amendment was seconded.

The motion as amended was carried.

A committee was appointed, and at the next day's session, presented the following report:

Your committee unanimously agrees to submit the following correction to Rule 88. The rule is to read as it is now written up to and including the words "Defect card" in the eighth line, and then follow with the words:

> Marked to show such improper material used and such consequent improper framing as may be found necessary, defect cards so issued and marked to cover labor only for correcting such improper repairs.

On motion, the report was adopted.

Rule 95

Mr. Jameson (Southern): I move Rule 95 be changed to read in this manner:

> Bills may be rendered against car owners for the labor only of replacing the following material when lost on the line of the company making the repairs: Couplers, including yokes, springs and followers when lost with the couplers; *metal draft arms and* friction draft gear complete, whether or not lost with the coupler.

Metal draft arms now lost on the line of road are billable against the car owner and the coupler is not billable. Metal draft arms are really of a greater value and have not lost any value. They are on the line of road and may be salvaged.

The motion was seconded and carried.

Rule 101

F. H. Hanson: I move that price be provided in Rule 101 for the lubrication of center plates and side bearings.

E. H. Mattingley: It seems to me in order to properly promulgate that rule it will be necessary to proceed along the same lines we did in order to get Rule 66 in the book. You will have to establish a periodical time of doing this so-called lubricating of center plates and side bearings. Otherwise, if we lubricate a car today and a fellow gets it five hundred miles from here, he will lubricate it again.

A. S. Sternberg: We do not want somebody to lubricate the side bearings and center plates on cars of ours every week and pay for it when it is not necessary. I do not think anybody else here does. You have a limit on triple valves, you have a limit on packing of the journal boxes and there should be a limit on this.

E. H. Mattingley: Every time we have made recommendations we have had to give our reasons and we have had to state how the rules should read.

F. H. Hanson: On the New York Central, we have standing orders for every car that goes on to the repair track where cars are jacked up so you can get at the center plates and side bearings, that they are to be greased. If we get a car in our shops today and somebody greased that a week ago, we are certainly not going to grease it again. Nine out of ten of the cars you get the center plates are dry, full of dirt and the side bearings are dry. In those cases we grease them and get nothing for it. The road that does that work should get something for it.

I do not expect to see it put in the rules this year because I agree that the Arbitration Committee expects us, when we make a recommendation, even to go further than he says. They would probably want us to set a price for doing that work, but by making this recommendation it might start something and in another year or so we might work up figures to show what the proper price should be and if necessary, how often this work should be done.

The motion was carried.

Rule 101

Mr. Jameson: In view of interpretation No. 7, following Rule 101, what scrap credit should be allowed if four follower plates weighing 90 lb. are removed on account of being too short and we apply four follower plates which weigh 120 lb.?

Mr. Martin: Rule 103 answers that.

Mr. Jameson: In the answer to question No. 7, following Rule 101, it does not say the weight of scrap. I contend that we are entitled to credit on only the weight of the material removed and charge the actual weight of the material applied.

P. M. Kilroy: I think that the answer is clear. In view of the fact that the Arbitration Committee allows you to credit the good followers removed as scrap, it fully compensates you for the difference in weight. The credit should be passed on Rule 103 as specified.

M. E. Fitzgerald: On page 108, item 175, it says, "Nut locks, or lock nut, all sizes, no credit for scraps, each two cents." Over in the column it says "four cents." Which is correct?

Mr. Jameson: Item 37, Rule 101 on page 104 reads, "Pipe nipple on end of train line, threaded, 12 in. or less in length, applied net includes material cost of nipple, on disconnection and connection only." That is evidently a misprint. Everybody asks what that word "on" means. I do not believe that the intention of the rule was to charge any additional connection.

M. E. Fitzgerald: There have been several hundred letters handled in the Association in connection with Rules 101 and 107. Various items are inconsistent and they will not check up. We ought to pass those rules assuming that they will take care of that unless there is some exception of considerable importance.

C. J. Wymer (C. & E. I.): I think we ought to call their attention to it.

Mr. Jameson: I move that we ask that Item 37, Rule 101, be re-written so that it is clearly stated what the forty-cent charge includes.

The motion was seconded and carried.

Mr. Jameson: Item 61, page 105, reading, "Nipples 12 in. or less in length" does not say that threads are included on the nipple. The Car Builders' Dictionary gives the definition of the nipple as a short piece of pipe threaded on both ends, yet various authorities are interpreting this price not to include the threads. I would like to have that item written intelligently so that there will be no question of a doubt left. I move that Item 61 be corrected to read:

> Nipples 12 in. or less in length, threaded on both ends.

The motion was seconded and carried.

Rule 107

Mr. Jameson: I move that we ask that Rule 107 be rearranged so that the items shall appear alphabetically. Some jobs are hidden away in there until it takes a man's time to locate them and it is not businesslike.

The motion was seconded and carried.

Mr. Jameson: Items 85, 112 and 219, Rule 107: What labor is to be charged for a center pin applied with renewal of center plate and the jacking of the car?

When you take a combination of those items, the question is open whether each item should be charged as stated in the rule, no one item referring to the other. When you make up a sample repair card and charge one key center pin, one hour and two-tenths labor; one body center plate on a bolt basis, four body center plate bolts, one hour and six-tenths; car jacked, one hour and five-tenths, it seems to be rather an exorbitant charge.

I move that we add to Item 112:

> Not to be allowed when center plate is renewed.

That means that you would allow no extra charge for renewing a center pin when the center plate was renewed at the same time at the same end.

The motion was seconded and carried.

M. E. Fitzgerald: Item 42a, page 125, allowing one hour for tightening truss rods on a loaded car, and Item 35 which allows one hour for applying the queen post including the R. & R. of turnbuckle and two nuts or two lags. This rule would allow one hour for tightening a truss rod on a loaded car and only one hour for tightening the rod and removing the queen post on another car.

I move that the rule be revised to include an allowance for the queen post in excess of the one hour for tightening the rod.

The motion was seconded and carried.

E. H. Mattingley: I would like to get an expression from some of the bill men as to the advisability of rendering a separate bill for the light weighing of cars. At the present time all bills for the repacking of journal boxes are rendered separately from the bill for the repairs. As the light weighing is not a maintenance charge, should we not have a separate bill for the light weighing?

Mr. Martin: We are burdened to death with separate bills. That question has come up in the auditing department as to whether it should be separated. It has been considered that the item is not of enough importance to separate it. We made a mistake when we made a separate charge for packing boxes.

President Pendleton: I have two communications addressed to the secretary, from W. J. Morris, master car builder, Atlanta, Birmingham & Atlantic, recommending changes in Rule 107, Item 401A, on the ground that the charges of labor for renewing or replacing truck springs is entirely too small for the actual time taken to do this work, since under ordinary conditions all truck springs cannot be replaced in one cluster in the allotted time; and suggesting that an interpretation be requested on Items 430 and 431, referring to the application of bolts over six inches in length in connection with the renewal of couplers.

C. C. Stone (Southern): I move that we ask the Association to change Item 431 to read,

> "When not on any bolt of six inches or *less* in length."

instead of having it read "Six inches or more."

The motion was seconded and carried.

Chairman Gainey: What about the springs, that is, Item 401A?

President Pendleton: The second paragraph of Mr. Morris' letter reads, "For your information this matter was referred to the Committee on Prices for Labor and Material at a recent meeting of the American Railroad Association and they decided that the additional charge for jacking should not be allowed, covered by Item 401A."

Mr. Jameson: It seems that disposes of it.

On Item 64 there is considerable confusion among the bill clerks as to the proper labor charge for a dead lever guide. The item reads, "Brake lever guide or carrier, renewed, each, five-tenths." We have been holding that that covered a dead lever guide. However, some of our car foremen believe that it covers the carrier to the floating lever under the center of the car, and the dead lever guide comes under the head of brake connections, rod or lever, or connection pin, two-tenths. We have dead lever guides that are bolted to the truck bolster and others that are secured with a key bolt.

Chairman Gainey: There are a great many of them riveted on. I think that the committee intended it for the dead lever guide, only they put the two words in there, guide or carrier.

Mr. Owen: I move that Item 64, Rule 107 be changed to read:

> "Brake lever guide or carrier to be charged on the bolt or rivet basis including key bolts."

There is a price for key bolts, I believe, which will cover that on the bolt and rivet basis.

Mr. Jameson: I think that ought to read. "On a rivet, bolt or key bolt basis."

The motion was seconded and carried.

M. E. Fitzgerald: I move that the word "hanger," the second word in Item 60A, be changed to "bearing," making it read:

> "Brake *bearing* secured by column bolts. Charge for column and brake hanger bolts used in securing same; allow for jacketing car when necessary."

A brake hanger is not so secured; it means brake bearing.

The motion was seconded and carried.

Mr. Jameson: Item 258 of Rule 107 reads: "Renailing roofing or siding, per lineal foot of nailing stringer, one cent." We have no charge for renailing flooring and I think we should be given one. I move that this item be changed to read:

> "Renailing roofing, siding *or flooring*, per lineal foot of nailing stringer, one cent."

The motion was seconded and carried.

E. H. Mattingley: I do not believe there is any item in Rule 107 that carries a labor charge for the framing of side ladder sills or cripple posts in connection with the removal of corner posts or other repairs. There should be some labor charge other than on a bolt or rivet basis because bolt basis will not allow sufficient labor for framing of those parts. I make that a motion.

The motion was seconded.

M. E. Fitzgerald: The price of lumber includes all framing in every case. I do not see why we should make a special provision for ladder sides.

E. H. Mattingley: Does the price of the lumber, which is eleven cents a foot, take care of the cost of the lumber and application, including the framing?

A. S. Sternberg: It might not in just this one case of ladder sides, but as a whole it does. It is a very good price.

Mr. Owen: As a rule ladder sides are taken out of stuff that is ripped from heavier timbers and it is not very often, unless they are putting on a great many ladder sides, that it has to come out of new material. The same thing applies to dead woods on 138A on a bolt and rivet basis; you haven't sufficient to cover your framing.

E. H. Mattingley: It is also true that the present rules do not provide for sufficient labor for the dead block. The charge on the bolt and nut basis, if the dead wood is secured in place by body truss rods only, labor for 2.1 hours for nuts and lag screws is not sufficient, taking into consideration the framing of the dead wood.

Mr. Owen: Most of the dead woods do not average over about thirty inches in length and they come off of the ends of timbers.

E. H. Mattingley: I cannot agree that the dead woods as a rule are made from scrap. It is very often necessary to rip or cut down a large piece of timber to make a dead block. Wood used for such purposes must be sound and of good quality, and if you are going to use scrap, you are not complying with the rules.

The motion was lost.

M. E. Fitzgerald: In connection with repairs to tank cars I call your attention to Item 278B which reads, "Running board, tank cars, end or side, renewed; per lineal foot, including all bolts, fitting and boring, eleven cents a foot." It is impossible to recover thirty per cent of the value of material and work performed in repairing running boards on tank cars. I move that a new price be applied to Item 278B. In many cases we have sixty-nine bolts in the corner of a tank car and it would not pay for the bolts.

The motion was seconded and carried.

Mr. Jameson: Item 275A reads, "Running boards, latitudinal, from side ladder to longitudinal running board, secured by bolts, renewed, per single board, four-tenths hours for ordinary cars and for refrigerator cars, four hundredths hours." It is an error in printing. I move that we ask that it be corrected.

The motion was seconded and carried.

E. H. Mattingley: I move that a resolution be presented by this Association to the Arbitration Committee calling particular attention to the large number of tank cars now in service and the very few items listed in Rules 101 and 107 to cover charges for repairs to tank cars, requesting them to give the matter special attention and provide more charges for such work.

The motion was seconded.

Secretary Elliott: The underframe should be covered in the other rules. It seems to me on the tank itself is pretty well covered on the rivet basis, hours labor for straightening, testing, etc. Do you have any items in mind that are not covered?

E. H. Mattingley: A great many of our tank car friends are making repairs to the tank itself, and billing for boiler maker labor, blacksmith labor, etc.; there are many different rates in effect at those plants and they are not uniform. The price committee should be able to provide ample charges, as they have done for the steel underframe of the same car, to compensate the owner for the repairs made by him. Why could we not have uniform charges for that work and get away from this unnecessary correspondence?

Mr. Jameson: We have an item in Rule 107 that covers those repairs. Item 443 reads: "Repairs of steel tanks of steel cars; labor repairing and testing, per hour, $1.45." I believe that word "Steel" has been stricken out, making it read: "Repairs of steel tanks of tank cars; labor repairing and testing, per hour, $1.45."

F. H. Hanson: I agree with Mr. Mattingley, but we recently have had several cases where the owner would present a bill showing possibly a third or a half more than the M. C. B. prices per hour, and when we would refer them to the A. R. A. rules they would say, "We are not a party to this; we do not care what your prices are. This is what it cost us to get the tank repaired and this is what we expect you to pay. Since some of those cases came up with us, we issued a defect card, accompanied with a letter telling them, "This carries with it information making the repairs covered by the defect card in accordance with the A. R. A. rules." In one case that I recently know of, the owner came back and told us that it would be impossible for him to get his car repaired on that basis and if we would not stand the extra charge he preferred that we take the car in our shops and put it in good condition, which we did. I would like to know how you are going to get a rule covering that.

P. M. Kilroy: The defect card, when you attach it to the car, governs the price that shall be charged between parties to the rules. You cannot bind an outsider by virtue of attaching a defect card to the car. That is the reason tank car companies are charging you what it really costs them.

E. H. Mattingley: I have in mind the tank car companies that are parties to the present rules. Most of our large tank car companies are parties to the rules.

Mr. Martin: The great trouble with bills for repairs to tank cars is that there is no uniformity. You get a bill and you get so many hours labor in accordance with Rule 107, Item 443. It is a practical impossibility under the present rules to check the repairs to a tank car. I do not see why we cannot get to a rivet basis on repairing the cistern of a car.

The motion was carried.

C. C. Stone: I move that Item 158 of Rule 101 be placed in Rule 107. Rule 101 covers material charges and Rule 107, labor charges.

The motion was seconded.

Secretary Elliott: You would have the same confliction when you got to Rule 107 as now. When you get to Rule 107 you could as well ask to have it put back in 101 again. It is a double charge, isn't it? It is a net charge.

C. C. Stone: It used to be a net charge but it is not now.

The motion was carried.

Mr. Jameson: Items 170 to 176 inclusive, are draft timber items. None of these items specifies that it includes the R. and R. of coupler. The question has been raised, is it proper to make labor charge for the R. and R. of coupler, as per item of 107 in addition to the labor shown for the above draft timber items? Rule 110 now being eliminated leaves this an open question. Further, the labor on the majority of the draft timber items has been reduced, contrary to the general increase of labor items which, to my mind, indicates that the price committee intended that we should charge for the R. and R. of coupler when draft timbers were R. and R. or renewed.

I move that Items 170 to 176 of Rule 107 include coupler R. and R.

The motion was seconded.

M. E. Fitzgerald: You previously stated that the labor charge now quoted was reduced and you wanted it added, I believe. If so, your motion as put is wrong.

Mr. Jameson: I said exactly what I intended to say. Under the present reading of the rules, I believe that you have a perfect right and can substantiate your charge for coupler R. and R. at the same time draft timbers are R. and R. renewed. However, I do not believe you should have four hours additional for applying coupler with draft timbers. Therefore, I made my motion as I think it really should be. Under the rules as they now read, you can charge for coupler R. and R. That is my opinion. I think that the draft timber items should include the R. and R. of coupler as it does the other items.

Mr. Martin: I think the intent is to eliminate overlapping labor and as far as possible to make the labor charge on each and every individual item. I think that the charge as it is, allowing for the R. and R. of coupler in addition to the charge is proper.

A. S. Sternberg: Page 120, Rule 107 says: "Unless otherwise specified, the labor allowances include all work necessary to complete each item of repairs." It appears to me that takes care of it.

Chairman Gainey: Strict reading of the rules does not allow you for dropping that coupler and putting it up. It pays you for putting up the draft timber and all work included in that and the rule is plain on that.

The motion was lost.

Mr. Jameson: Then I would like to have this body express an opinion on that. I move that we go on record to the effect that Items 170 to 176 of Rule 107 include the R. and R. of coupler.

The motion was seconded and carried.

(*The proceedings of the meeting will be concluded in the July issue.*)

Labor Board Announces General Wage Reduction

Average Decrease in Rail Rates Is 12 Per Cent; Shop Crafts Cut 8 Cents an Hour, or 9 Per Cent

A GENERAL wage reduction in which the rates for practically all shop employees were lowered 8 cents an hour was announced by the Railroad Labor Board on May 31. The ruling it is estimated will reduce the total payrolls of the railroads about $400,000,000 a year. The reduction becomes effective July 1, the date which the national agreements will be abrogated.

The average percentage of reduction, as estimated by members of the Labor Board, is 12 per cent. The decreases in wage rates vary from 5 to 13 cents, or from 5 to 20 per cent. The majority of the shop crafts receive a reduction of 9 per cent, while car repairers' wages are cut about 10 per cent. For section men the reduction is approximately 18 per cent and completely wipes out the increase granted in the wage award of July, 1920. The pay of common labor, on which the railroads sought to obtain the greatest reduction, is to be cut 6 to 8½ cents an hour.

Passenger and freight engineers, who received increases of 10 to 13 cents an hour by the 1920 award, are to be cut 6 and 8 cents an hour respectively. Passenger and freight conductors who received increases of 12½ and 13 cents in 1920 are cut 7½ and 8 cents by the new schedule. The smallest reduction will apply to office boys and other employees under 18 years old who will receive 5 cents an hour less after July 1. This takes away the increase granted last year.

Clerks are reclassified so that entering clerks will receive a monthly salary of $67.50 for the first six months and $77.50 for the second six months of service. Clerks with less than one year's experience now receive $120.

A new monthly schedule for floating equipment employees on ferries, tugs and steam lighters gives captains $200, engineers $190, and firemen and oilers $140. On lighters and barges captains will receive $120 to $150; engineers, $140 to $160, and mates, $100.

New Rates Will Be Applied on All Roads

While the decision affects only 104 roads, it will apply eventually to every railway in the country. About 100 roads whose requests for reductions were filed after April 18, when the hearing started, will present their cases to the board commencing June 6. Some of the roads sought reductions in common labor only; others included other groups and some have asked new wage scales for all classes. The board's decision sets up new uniform scales for all groups of employees and instructs each company involved to apply the new scales to the special groups whose pay it has asked to have reduced.

Reduced costs of living and reduced wages in other industries were the major factors on which the wage cuts were based by the board. The decision points out that the adjustment period has produced conditions in whose burdens all have to share. It says the wage problem with which it dealt is an economic one and should not be regarded as a struggle between capital and labor or the managements and employees.

In a supplemental memorandum the board points out that during government control the wages of railway employees were increased from an average of $78 a month in December, 1917, to $116 in January, 1920, or about 20 per cent. The board's decision last year, effective May 1, 1920, increased wages 22 per cent, or to an average of $141 a month. After this increase the workers, according to the findings, were receiving an average of 81 per cent more than they were getting before Federal control and about 10 per cent of the number, chiefly the lower paid unskilled workers, had received increases in excess of 100 per cent. The board estimates that the cuts of 12 per cent would mean an average monthly wage of about $125 for all employees.

In its decision the board sets forth some of the conclusions on which it acted as follows: It finds that since the rendition of its decision No. 2 (last year's wage increase) there has been a decrease in the cost of living. What that decrease has been it is impossible to state with mathematical accuracy, or even what the general average for the United States has been up to and on any given date. The machinery for procuring and stating with accuracy the data to fix this is by no means perfect. The decreases vary greatly according to the locality, and affect different persons in different degrees. In the cities the general decreases in some lines have been offset to some extent by the high rents. In some of the items in the cost of living the fall in prices has been great, in others much less.

The board also finds that the scale of wages for similar kinds of work in other industries has in general been decreased. The decreases vary in different industries and in different localities. There has been a decrease and the present tendency is downward.

But the most unfortunate condition is that in many localities large numbers are out of employment on account of the prevailing depression and hence without wages.

In a decision of this character it is not practical to fix rates applying with exact ratio to each individual employee and each separate locality, for the reason that necessity compels the board to accept certain standardizations of pay for railroad employees. But these standards are now somewhat different in different regions and so the decreases will have relatively the same general effect.

There are certain facts and conditions known to all and which can neither be disputed nor ignored. Whatever may be said as to the origin or contributing causes there has been and is a marked, and to some extent distressing and disastrous, depression in business and industry affecting the entire country and some lines of production most seriously. As a result heavy financial losses have been suffered and many hundreds of thousands thrown out of employment and deprived of all wages and this loss of purchasing power by them has in turn accelerated the general depression by reducing the demand for the products they would otherwise have purchased.

While it has been argued that the fall in prices has not reached the consumer to any large extent, it has without question most disastrously reached and affected the producers, especially some lines of manufacture and the agricultural classes. It should be recognized by all that the problem before us is chiefly an economic one and we are all confronted by adverse and troublesome conditions which every one must help to solve.

Details of Wage Cuts

The reductions per hour for the various classes of employees under the decision are as follows:

Article II—Clerical and Station Forces

For the specific classes of employees listed herein and named or referred to in connection with a carrier affected by this decision, use the following schedule of decreases per hour:

(Note—For clerks without previous experience hereafter entering the service of a carrier, rates of wages specified in Sec. 3 (b), this article, are hereby established.)

Sec. 1. Storekeepers, assistant storekeepers, chief clerks, foremen, sub-foremen and other clerical supervisory forces....................6 cents.

Sec. 2. (a) Clerks with an experience of two (2) or more years in railroad clerical work, or clerical work of a similar nature in other industries, or where their cumulative experience in each clerical work is not less than two (2) years..6 cents.

(b) Clerks with an experience of one (1) year and less than two (2) years in railroad clerical work, or clerical work of a similar nature in other industries, or where their cumulative experience in such clerical work is not less than one (1) year.................................13 cents.

Sec. 3. (a) Clerks whose experience as above defined is less than one (1) year ....6½ cents.

(b) Clerks without previous experience hereafter entering the service will be paid a monthly salary at the rate of sixty-seven dollars and fifty cents ($67.50) per month for the first six (6) months, and seventy-seven dollars and fifty cents ($77.50) per month for the second six (6) months.

Sec. 4. Train and engine crew callers, assistant station masters, train announcers, gatemen and baggage and parcel room employees (other than clerks) ....10 cents.

Sec. 5. Janitors, elevator and telephone switchboard operators, office, station and warehouse watchmen, and employees engaged in assorting, way bills and tickets, operating appliances or machines for perforating, addressing envelopes, numbering claims and other papers, gathering and distributing mail, adjusting dictaphone cylinders and other similar work.... ....10 cents

Sec. 6. Office boys, messengers, chore boys, and other employees under eighteen years of age, filling similar positions, and station attendants.5 cents.

Sec. 7. Station, platform, warehouse, transfer, dock, pier, storeroom, stock room and team-track freight handlers of truckers, and others similarly employed..6 cents.

Sec. 8. The following differentials shall be maintained between truckers and the classes named below:

(a) Sealers, scalers and fruit and perishable inspectors, one (1) cent per hour above truckers' rate as established under section 7.

(b) Stowers or stevedores, callers or loaders, locators and coopers, two (2) cents per hour above truckers' rate as established under section 7. The above shall not operate to decrease any existing differentials.

Sec. 9. All common laborers in and around stations, store houses and warehouses, not otherwise provided for........................8½ cents.

Article IV—Shop Employees

(Note—For car cleaners' rates of wages fixed by a differential shown in section 4, this article, are hereby established.)

Sec. 1. Supervisory forces......................................8 cents.

Sec. 2. Machinists, boilermakers, blacksmiths, sheet metal workers, electrical workers, carmen, moulders, cupola tenders and coremakers, including those with less than four years' experience, all crafts........8 cents.

Sec. 3. Regular and helper apprentices and helpers, all classes..8 cents.

Sec. 4. Car cleaners shall be paid a rate of two (2) cents per hour above the rate established in section 6 of article III, this decision, for regular track laborers at points where car cleaners are employed.

Article VI—Engine Service Employees

Sec. 1.—Passenger Service

Class	Per mile	Per day
Engineers and motormen	$0.48	$0.48
Firemen (coal or oil)	.48	.48
Helpers (electric)	.48	.48

Sec. 2.—Freight Service

Engineers (steam, electric or other power)	$0.64	$0.64
Firemen (coal or oil)	.64	.64
Helpers (electric)	.64	.64

Sec. 3.—Yard Service

	Per hour
Engineers	$0.08
Firemen (coal or oil)	.08
Helpers (electric)	.08

Sec. 4.—Hostler Service

	Per day
Outside hostlers	$0.64
Inside hostlers	.64
Helpers	.64

Article VII—Train Service Employees

Sec. 1.—Passenger Service

Class	Per mile	Per day	Per month
Conductors	$0.004	$0.60	$18.00
Assistant conductors or ticket collectors	.004	.60	18.00
Baggagemen handling both express and dynamo	.004	.60	18.00
Baggagemen handling express	.004	.60	18.00
Baggagemen	.004	.60	18.00
Flagmen and brakemen	.004	.60	18.00

Sec. 2.—Suburban Service (Exclusive)

Conductors	$0.004	$0.60	$18.00
Ticket collectors	.004	.60	18.00
Guards performing duties of brakemen or flagmen	.004	.60	18.00

Sec. 3.—Freight Service

Conductors (through)	$0.64	$0.64	....
Flagmen and brakemen (through)	.64	.64	....
Conductors (local or way freight)	.64	.64	....
Flagmen and brakemen (local or way freight)	.64	.64	....

Sec. 4.—Yard Service

Class	Per mile	Per day	Per month
Foremen	....	.64	....
Helpers	....	.64	....
Switchtenders	....	.64	....

Article VIII—Stationary Engine (Steam) and Boiler Room Employees

Sec. 1.	Stationary engineers (steam)	$0.08
Sec. 2.	Stationary firemen and engine room oilers	.08
Sec. 3.	Boiler room water tenders and coal passers	.06

Article XII—Miscellaneous Employees

Sec. 1. For miscellaneous classes of supervisors and employees in the hereinbefore named departments properly before the Labor Board and named in connection with a carrier affected by this decision, deduct an amount equal to the decreases made for the respective classes to which the miscellaneous classes herein referred to are analogous.

Sec. 2. The intent of this article is to extend this decision to certain miscellaneous classes of supervisors and employees submitted by the carriers, not specifically listed under any section in the classified schedules of decreases, and authorize decreases for such employees in the same amounts as provided in the schedules of decreases for analogous service.

Article XIII—General Application

The general regulations governing the application of this decision are as follows:

Sec. 1. The provisions of this decision will not apply in cases where amounts less than thirty dollars per month are paid to individuals for special service which takes only a part of their time from outside employment or business.

Sec. 2. Decreases specified in this decision are to be deducted on the following basis: (a) For employees paid by the hour, deduct the hourly decrease from the hourly rate. (b) For employees paid by the day, deduct eight times the hourly decrease from the daily rate. (c) For employees paid by the month, deduct two hundred four times the hourly decrease from the monthly rate.

Sec. 3. The decreases in wages and the rates hereby established shall be incorporated in and become a part of existing agreements or schedules or future negotiated agreements or schedules, and shall remain in effect until or unless changed in the manner provided by the Transportation Act, 1920.

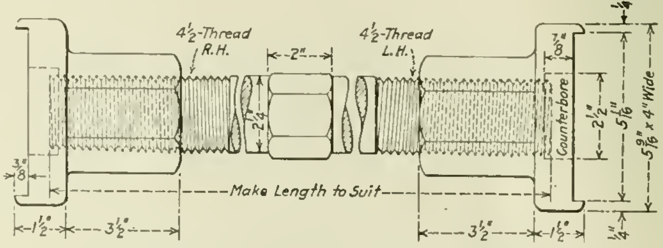
Sec. 4. It is not intended in this decision to include or make decreases in wages for any officials of the carriers affected except that class designated in the Transportation Act, 1920, as "Subordinate Officials" and who are included in the act within the jurisdiction of this board. The act provides that the term "Subordinate Officials" includes officials of carriers of such class or rank as the Interstate Commerce Commission shall designate by regulation duly formulated and issued. Hence, whenever in this decision words are used, such as foremen, supervisors, etc., which may apply to officials, such words are intended to apply to only such classes of subordinate officials as are now or may hereafter be defined and classified by the Interstate Commerce Commission as "Subordinate Officials" within the meaning of the Transportation Act, 1920.

The decision stipulates that its provisions are not to apply in cases of employees receiving less than $30 a month for special service requiring only part time.

Railway executives expressed disappointment when informed of the decreases and several stated they considered them inadequate under present conditions. B. M. Jewell, president of the Railroad Department of the American Federation of Labor, refused to make any comment.

Device for Spreading Locomotive Frames

The illustration shows a device for spreading locomotive frames previous to Thermit welding. It was developed by the blacksmith foreman of the Yazoo & Mississippi Valley at Vicksburg, Miss., and can be used between pedestals or long sections of frames by applying different length screws. The device is simple, effective and easily manufactured in any railroad shop.



Adjustable Frame Spreading Device

NEW

AND IMPROVED

MACHINE TOOLS

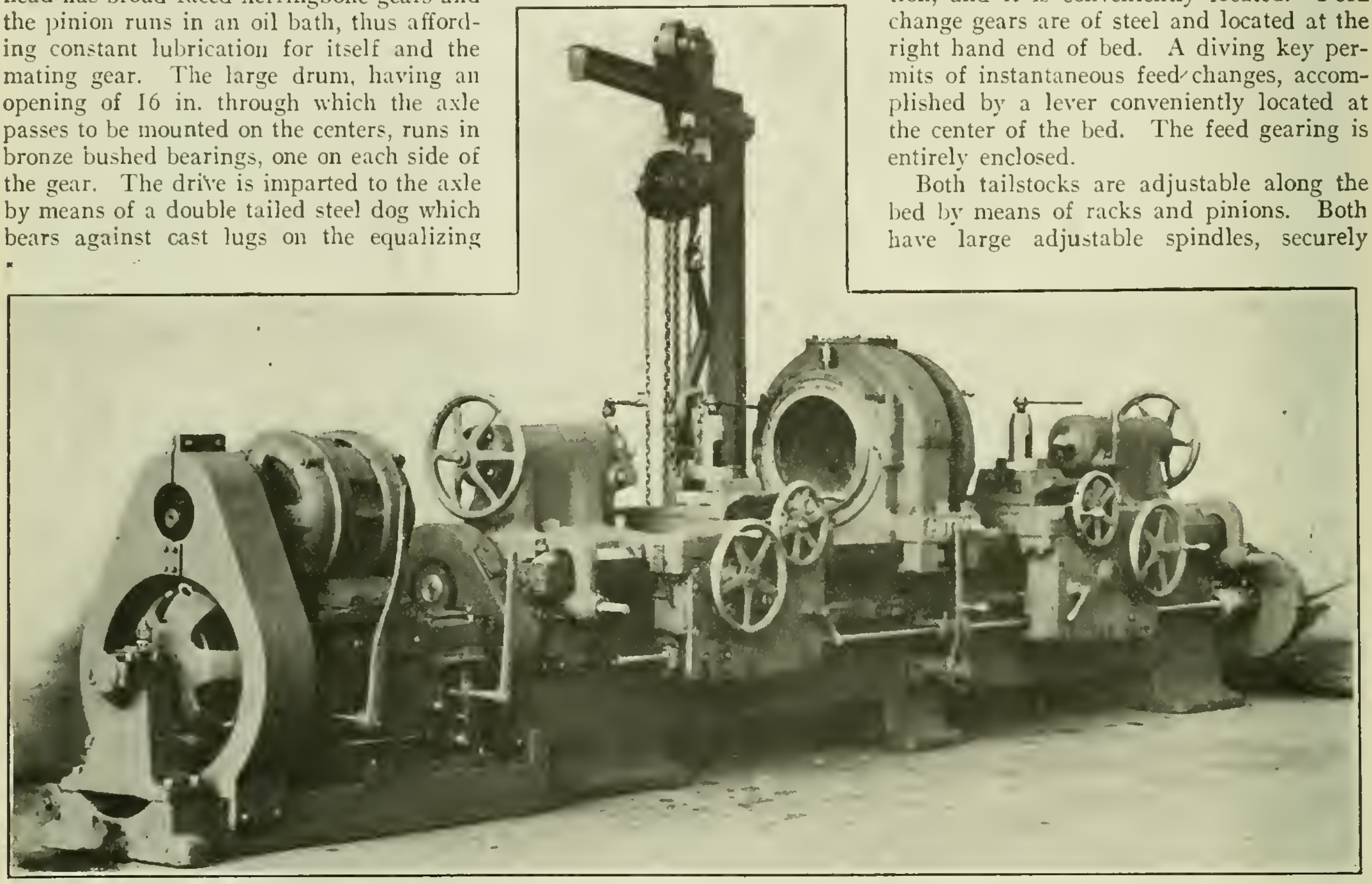
AND

SHOP EQUIPMENT

High Production Double Axle Lathe

Many valuable features are included in the heavy duty double axle lathe recently developed by the Putnam Machine Works of Manning, Maxwell & Moore, Inc., Fitchburg, Mass. These features include ease of manipulation, accuracy and plenty of power and weight to take heavy cuts without vibrating. The general ruggedness of the machine as a whole is evident from the illustration.

The machine bed is a deep box section with side walls connected at short intervals by broad box ties. Longitudinal trusses are provided, having cast racks against which the tailstocks are braced for severe duty. The center driving head has broad faced herringbone gears and the pinion runs in an oil bath, thus affording constant lubrication for itself and the mating gear. The large drum, having an opening of 16 in. through which the axle passes to be mounted on the centers, runs in bronze bushed bearings, one on each side of the gear. The drive is imparted to the axle by means of a double tailed steel dog which bears against cast lugs on the equalizing plate. The action obtained by the use of herringbone gearing is one of extreme smoothness of cutting and freedom from chatter. The head is clamped to the bed by six large bolts.



Ease of Operation, Accuracy and High Power Are Features of the New Putnam Axle Lathe

The carriages are guided by large V-ways on the front and rear of the bed, an additional flat bearing being provided directly under the tool. This not only furnishes a rigid support for the tool blocks, but by reducing the span of the carriage bridge between the ways insures freedom from distortion and subsequent binding of the carriage. The carriages are gibbed on horizontal and vertical surfaces directly in line with the tool thrusts. A large poppet and ring provide a convenient means of locating and clamping the tool. Cast channels in the carriage carry the cutting lubricant to a trough at the rear of the bed. Sliding surfaces are protected by wipers attached to the carriage.

The feed aprons are of rigid, double wall construction, furnishing support for all shafts at both ends. The feed motion is transmitted through a worm and worm wheel. The worm receives its power from a double splined shaft on the front of the bed. All radial and thrust loads on the worm are absorbed by large ball bearings. The feed is thrown in or out of engagement by a small, conveniently placed lever which in turn operates a positive jaw clutch, no friction being used. An automatic stop disengages the feed at any predetermined point. The worm and wheel, together with the absence of distortion in the apron, impart an unusually smooth motion to the tool.

Special attention has been paid in the design to reducing the overhang of the apron beyond the edge of the bed. This allows the operator to get close to the work. The position of the hand-wheel has likewise been given careful consideration, and it is conveniently located. Feed change gears are of steel and located at the right hand end of bed. A diving key permits of instantaneous feed changes, accomplished by a lever conveniently located at the center of the bed. The feed gearing is entirely enclosed.

Both tailstocks are adjustable along the bed by means of racks and pinions. Both have large adjustable spindles, securely clamped by means of plug binders. Permanent alinement of spindles is maintained by means of taper gibs, one on each tailstock body. Pawls attached to the body engage cast racks in the bed to prevent slipping under heavy cuts. A crane for handling axles in and out of the lathe is furnished when ordered and a one ton quick acting hoist is provided. The liberal use of ball and roller bearings makes it an easy matter for one man to operate the hoist.

A centrifugal pump supplies the cutting lubricant directly to the tools by means of conveniently located pipes. This pump takes the lubricant from a tank attached to back of the bed. It returns to the tank by means of large, open channels, thus preventing trouble by pipes clogging.

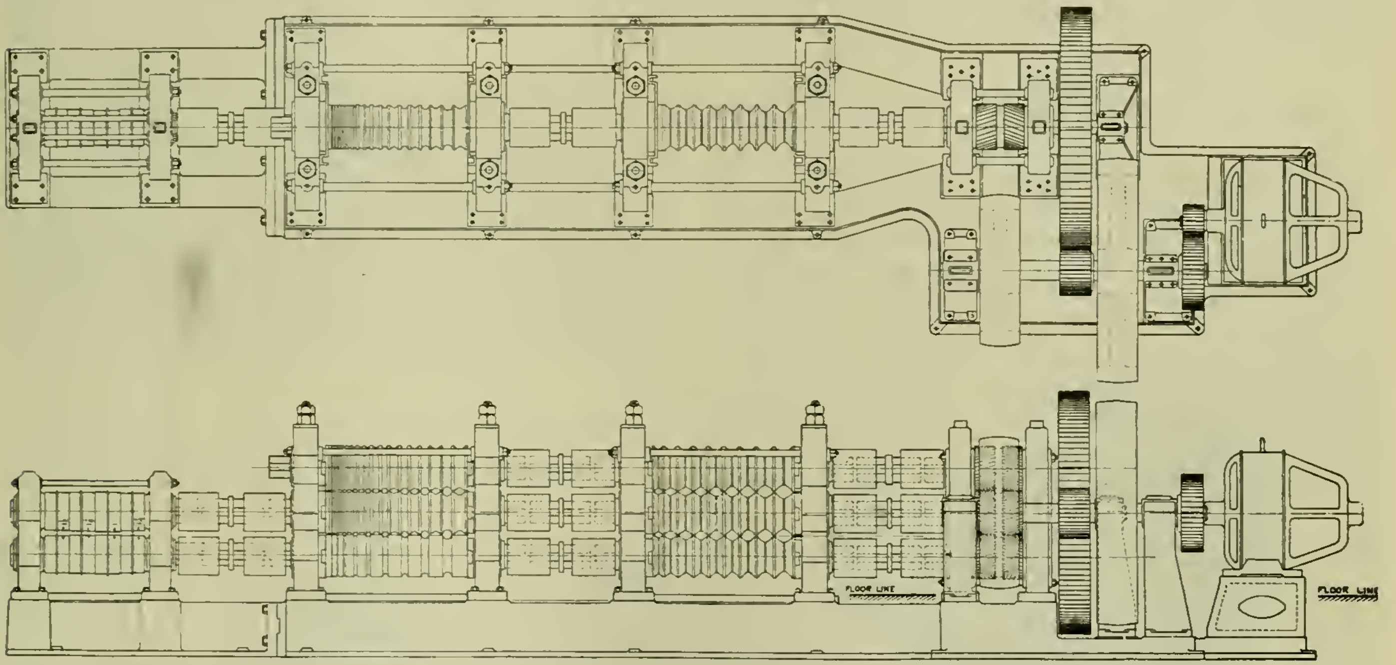
Machines can be furnished with any one of four types of drive; namely, single pulley belt drive, constant or variable speed motor drive, or four step cone pulley belt drive and countershaft. When driving by a single pulley belt, or constant speed motor, drive is through a unit and self-contained gear box, giving four speeds in geometrical progression through sliding gears. These gears are all of chrome nickel steel, heat treated and hardened, and operate under continuous flood lubrication. A gear shifting lever, positively interlocking in every position, makes it impossible to engage conflicting gear trains at any time.

When the machine is belt driven, power is transmitted to the gear box through a single pulley of large diameter and wide face, running at constant speed. For starting and stopping, a powerful friction clutch is employed. Two control levers for this clutch are provided, one near the carriages at the operator's natural position, and the other at the gear box, to be used when shifting gears. When stopping the lathe, the act of disengaging the friction clutch automatically applies a friction brake, bringing the machine to a full stop almost instantly. Moreover, the interlocking mechanism is such that the friction clutch must be released and the brake applied before gears can be shifted for a speed change.

New Model Scrap Reclaiming Rolls

In order to increase the general utility of their scrap reclaiming rolls, the Ajax Manufacturing Company, Cleveland, Ohio, has recently evolved a new rolling machine which, without changing the rolls, can be used for re-rolling rod scrap, longitudinal slitting, re-rolling arch bars and other flats, and rolling bundled or fagoted iron scrap.

The new model rolls possess the combined advantages of all previous models. Two main stands of three-high rolls are provided and a small stand of two-high splitting rolls capable of splitting various sizes of flats preliminary to rerolling. The rolls are built in two sizes: A, 12 in. by 40 in. and B, 14 in. by 44 in. direct gear, motor driven by 100 hp. and 150 hp. motors, respectively.



Ajax Scrap Reclaiming Rolls as Recently Redesigned and Improved

The one main stand is equipped with rolls having Gothic roughing grooves for breaking down large bars or billets and fagoted iron scrap. The A mill has a capacity for 2½ in. rounds or billets and 3½ in. square fagots; the B mill will handle 3½ in. rounds or billets and 4½ in. fagots. The second main stand carries the finishing rolls, the grooving of which depends entirely upon the kind of stock to be produced. By placing as many roughing grooves as possible in the roughing rolls practically all the reduction can be effected in them and only two passes are taken in the finishing rolls to produce the proper size. This minimizes wear on the finishing grooves so that the stock runs true to size and the finishing rolls do not require frequent redressing.

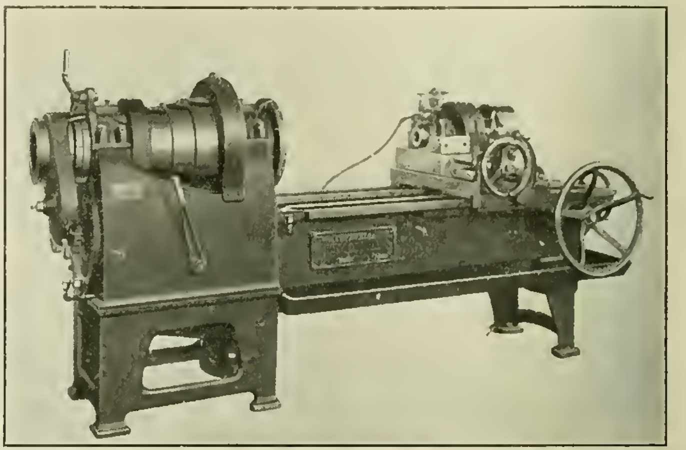
Hollow Spindle Thread and Form Miller

Designed to mill either internal or external, right or left hand, straight or taper, single or multiple threads of any form, the Smalley-General Company, Inc., Bay City, Mich., announces an improved hollow spindle thread and form miller. Special effort has been made to provide a machine as simple, efficient and reliable as possible, combining strength and accuracy.

The essential parts of the machine are evident from the illustration which shows the powerful cone pulley drive and the main spindle adapter to carry the work or chuck. The lead screw is connected with the main spindle by means of a change gear train. The main spindle is timed with the milling carriages by means of a patented clamping device. During the milling operation while the work makes one revolution, the milling head or carriages are moved back by the lead screw and clamping device a distance amounting to the pitch of the thread to be milled. The No. 23 machine, illustrated, has a swing of 20 in. and can be furnished with beds of various lengths. The "A" size machine has a distance of 2 ft. between the face plate and the milling spindle. The normal milling capacity is 13 in. outside diameter and 17 in. inside diameter. The length of external thread is approximately 5 in. depending on the pitch. The length of the internal thread depends upon the inside diameter; the larger the diameter, the longer the thread. It is not practical to mill absolutely square threads.

The No. 23 machine has a lathe speed bearing a constant proportion to every milling speed. The change from milling to lathe speed is obtained instantly by shifting the lever located on the head of the machine. Lathe work such as turning, boring and facing can be done at lathe speed. The advantage of this arrangement can be readily seen because with practically each thread there is an adjacent shoulder which must be normal to that thread. By throwing in the lathe speed the surface can be done at lathe speed at the same chucking, thus securing the desired alinement. It also saves an additional chucking operation. Tools for lathe work are located on the top slide, an auxiliary tooling slide being provided on the ways of the machine when desired.

The cross slide is controlled by means of a micrometer screw determining the diameter of the thread to be cut. The top slide carries the milling spindle which is driven through a three to one spiral gearing, thus giving it ample power and even torque. The bottom carriage when milling is clamped to the lead screw tube, located between the ways of the machine. Any kind of chuck suitable to the work in hand can be attached to the machine. By means of the lead screw tube, a thread can be started at any time or place, thus permitting the milling of interchangeable tapered threads. Production is increased because the operator does not have to wait for a split nut to come in contact, and wear on the lead screw during lathe operations is saved. With attachments available the Smalley-General thread miller is adapted to mill rapidly and accurately all forms of threads and all sizes within its capacity.

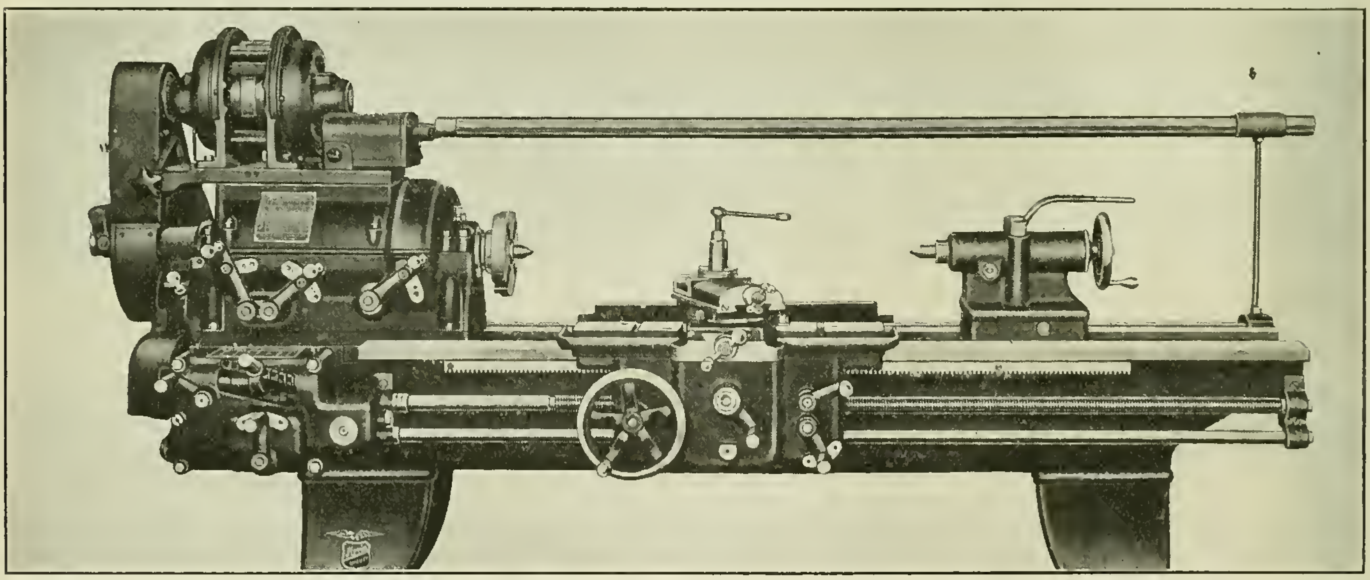


Smalley General No. 23 Thread Miller

Geared Head Lathe Made in Three Sizes

THE Morris Machine Tool Company, Cincinnati, Ohio, has placed on the market a geared head lathe made in 16-in., 18-in. and 22-in. sizes. Twelve spindle speeds are provided and, with a double friction countershaft, there are twenty-four speeds or twelve forward and twelve reverse. All gears are of steel, heat treated and hardened. The headstock is filled with oil up to a certain level permitting the gears to dip enough to be thoroughly lubricated by the splash system.

All speeds are secured through sliding gears and one positive back gear clutch, friction clutches or any parts requiring adjustment having been eliminated. The only friction clutch is in the pulley at the initial drive, which is of a large diameter, controlled by a shifter rod running the full length of the lathe. This permits the operator to start and stop the lathe from any working position. Speed changes are secured through the levers in front of the head. The two levers at the back end control a set of sliding gears giving six speeds. This lever, when engaging the direct drive clutch, slides the back gear pinion out of mesh, preventing the back gears running idle at high speed and from absorbing unnecessary power. When releasing the friction clutch in the pulley, a brake can be applied by the same pull which stops the idle rotation of the spindle. This is a great convenience both when shifting gears and when turning work partly around for inspection at different points on the diameter. The pulley is protected by a guard which can be swiveled to suit the angle of the belt.



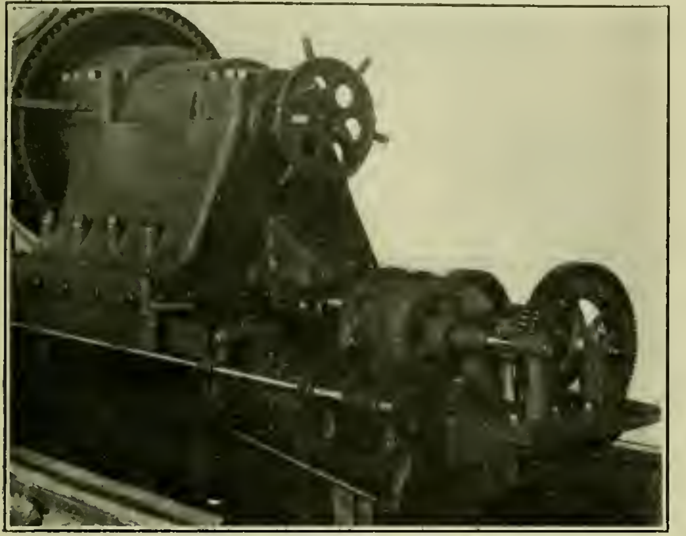
Morris Geared Head Lathe Made in 16-In., 18-In. and 22-In. Sizes

The Morris geared head is interchangeable with the cone head. All geared heads are arranged to receive the motor drive unit at any time. The motor is mounted on a plate, bolted to the head and drives the clutch pulley by an endless belt which is furnished with the motor drive details. An idler pulley adjusts the tension of the belt by means of the star handle at the front of the motor plate. The idler pulley and bracket are mounted on the motor plate, making the motor drive unit self-contained.

The speed range is in geometrical progression from 12 to 347 r.p.m. for the 16-in., 10 to 297 r.p.m. for the 18-in. and 10 to 297 r.p.m. for the 22-in. machine.

Fifty-Four Inch Tire Turning Lathe

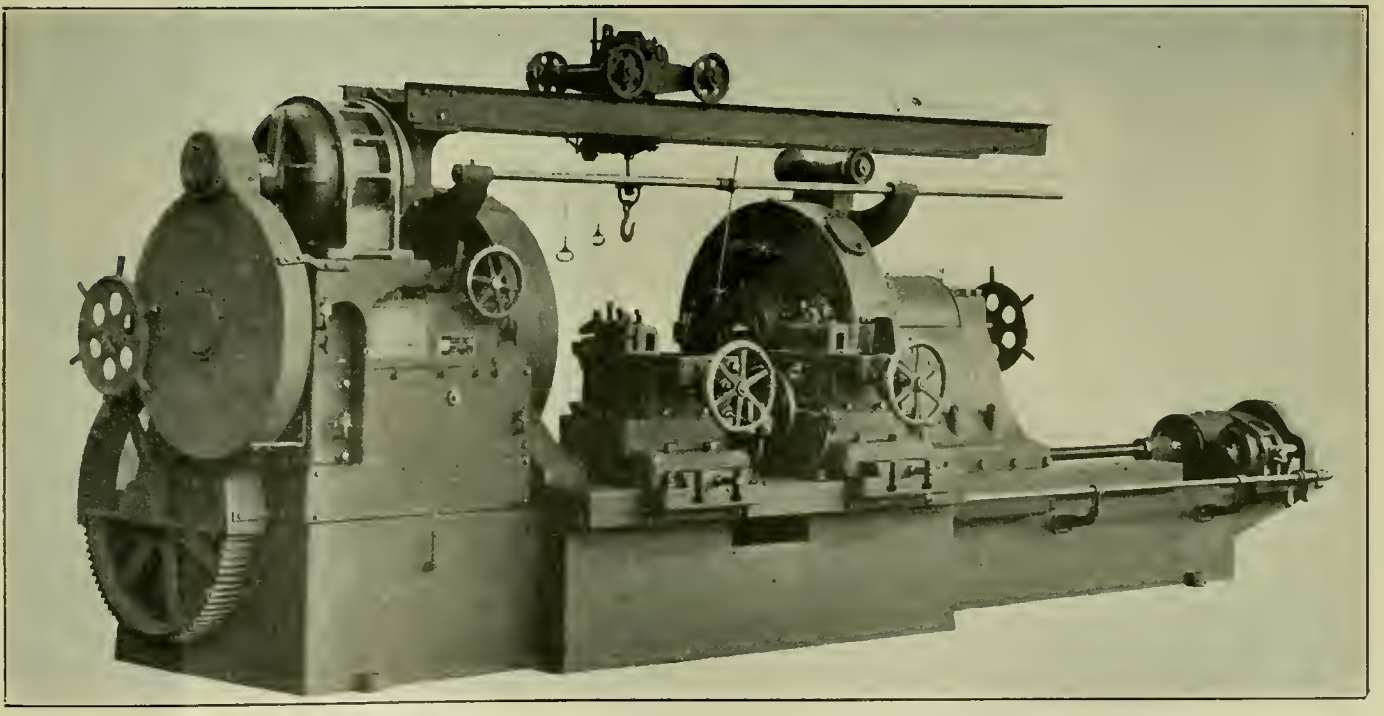
The Putnam Machine Works of Manning, Maxwell & Moore, Inc., Fitchburg, Mass., has extended its line of car wheel lathes to include a 54-in. heavy pattern machine for turning car, tender, and engine truck wheels. Wheels from 52 in. in diameter to the scrap limits of 30-in. wheels can be turned and a spindle nose capacity for chucking axles with journals as large as 10 in. in diameter by 16 in. long is provided. The machine is flexible and will handle not only standard but narrow gage equipment down to 3 ft. 6 in. gage.



View Showing Tailstock Adjusting Mechanism.

The lathe bed is deep, strongly cross-tied with a solid top to keep out chips. An important feature from the standpoint of ease of operation is the patented tool slide arrangement, known as the combination tool slide, which permits of rough turning and finishing tires complete to contour without changing tools. Each tool block carries a roughing tool and full width forming blade mounted side by side. When the roughing tool has finished its work, the forming blade by a slight movement of the tool slide is in position to be fed in for the finishing cut. This feature saves considerable time and labor and the tools do not have to be handled or changed until they become too dull to cut. The forming blades are held in position by a friction clamp so that they may be readily changed in a few moments. The tool slides are of steel and the tool slide bases have hardened and ground steel plates fastened to their surfaces to minimize wear.

The tailstock is moved along the bed either by an auxiliary 7½ hp. motor, or by an individual countershaft. The mechanism for this purpose allows the motor or countershaft to be started under no load, the control being a friction clutch and containing a relief which operates mechanically when the tailstock reaches a position where it is clamped. When the tailstock is in operating position, it is automatically clamped to the bed by a compensating clamp. In withdrawing the tailstock, when unloading, it is not necessary to reverse the direction of the motor. The headstock is permanently locked in like manner by the left hand tool block. The parts affected are tied together, so that the strains due to the cutting tools are self-contained within those parts;



Putnam 54-In. Lathe for Turning Car, Tender and Engine Truck Wheels therefore, when the tailstock is run to and clamped in position, both it and the headstock are firmly locked to their respective tool blocks.

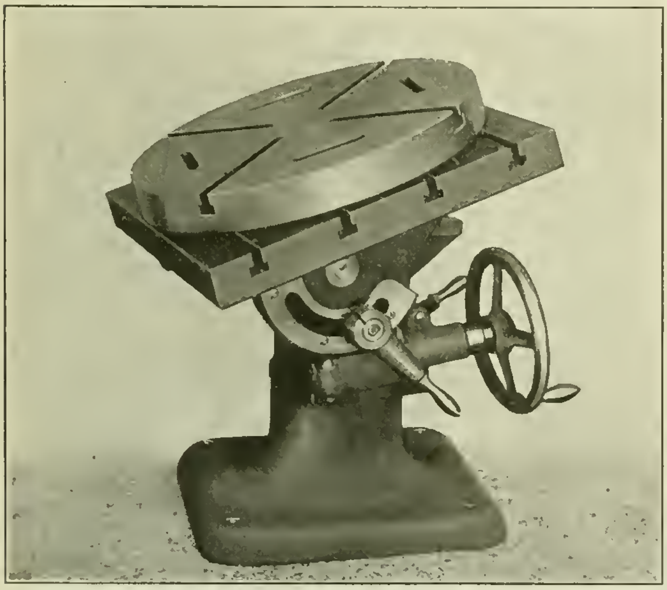
Both the headstock and tailstock main spindle bearings are bushed to facilitate maintaining the original accuracy of the spindle alinement. The internal spindles in the headstock and tailstock are controlled by spring pressure which automatically tightens the split chucking bushings which are slipped over the axle journals just prior to loading a pair of wheels into the machine. The end thrust, due to driving by serrated dogs, is taken by thrust collars located on the external spindles and running in a bath of oil. Spindles and face-plates are made in one piece. Each face-plate is equipped with four Putnam non-slip driving dogs. The maximum distance between the face plates is 10 ft. 9⅞ in., while the width of the faceplates, including the face of the ring gears is 12 in.

The machine is designed for three types of drive which are interchangeable: single pulley belt drive, constant speed motor drive, or adjustable speed motor drive. The general design of the headstock is the same for each type of drive, except that for the single pulley belt drive or the constant speed motor drive more gears are provided to give the necessary number and range of tire turning speeds. A lathe furnished with any one of these three drives may be readily converted into any of the other types.

A calipering attachment is furnished, which remains attached to the machine. When specified, the machine can be equipped with a pneumatic crane for rapidly handling wheels in and out of the lathe.

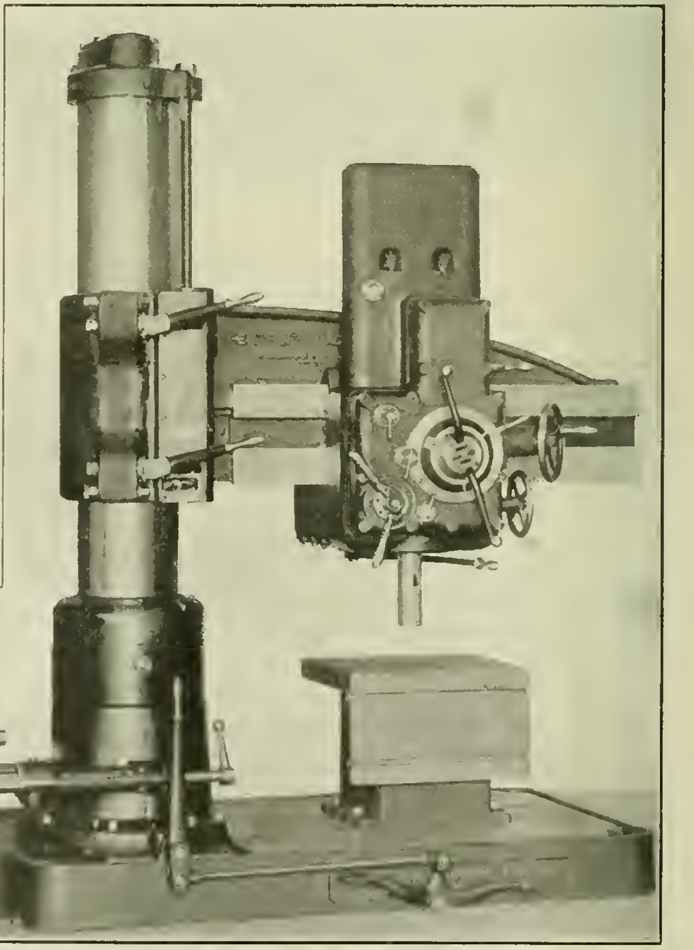
Ball Bearing Heavy Duty Radial Drill

ALL revolving parts of the new line of radial drills brought out by the Carlton Machine Tool Company, Cincinnati, Ohio, are equipped with high grade ball bearings to take both the radial and thrust loads. In addition the general design of the machine has been such as to make it a heavy duty machine. The low hung principle of drive has been incorporated in this machine bringing the driving gear under the arm and at the lowest position in the head. The result is a steady powerful drive. The unit principle of construction has been utilized, the driving and feed mechanism as well as the tapping and reversing attachment being independent units, assembled in an oil tight case on shafts, supported at each end in large ball bearings.



Round Table Which Is Fully Universal

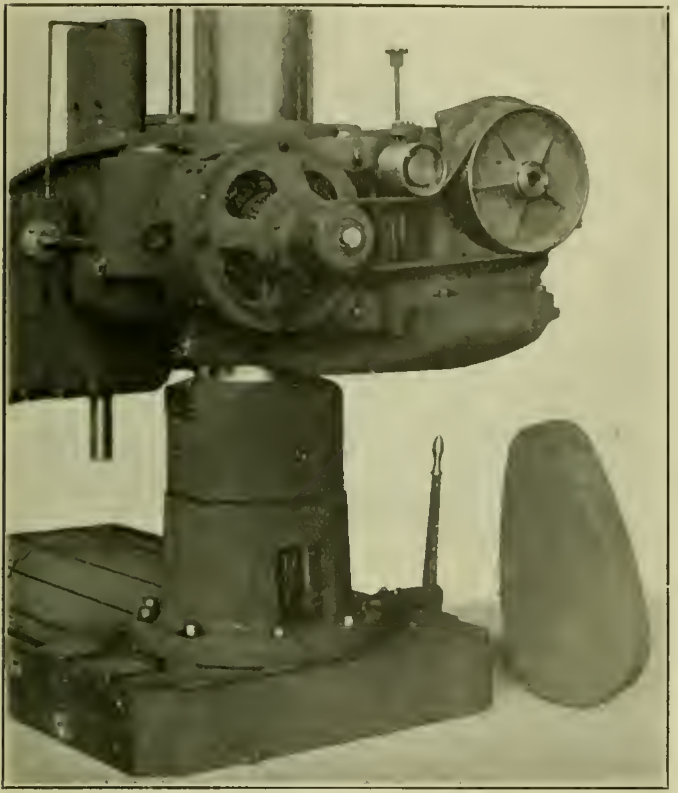
The speed control lever is within convenient reach of the operator and six speeds may be obtained by means of a sliding gear. The speed box is connected to the stump knee by a coupling. Bevel gears running in a bath of oil carry the drive to the vertical shaft. Each gear is mounted on a sleeve or shaft supported on both ends by ball bearings. The arm is raised and lowered by means of a pair of bevel gears and a tumbler gear.



Carlton Radial Drill Arranged for Constant Speed Drive Through Gear Box

Control of the arm is by means of a lever on the bottom and this is inter-locked in neutral position when the arm is tightened to the column. The operator cannot engage operating gears without first loosening both levers. When the arm travels to the maximum height on the column it is stopped automatically by a plunger and when lowering, if it meets any obstruction, it is also stopped automatically. Neither the inner nor outer column is split. The locking mechanism is operated by a hand lever or foot treadle. The arm is finished with long, flat ways affording a substantial bearing for the head, which is entirely enclosed and consists of sub units.

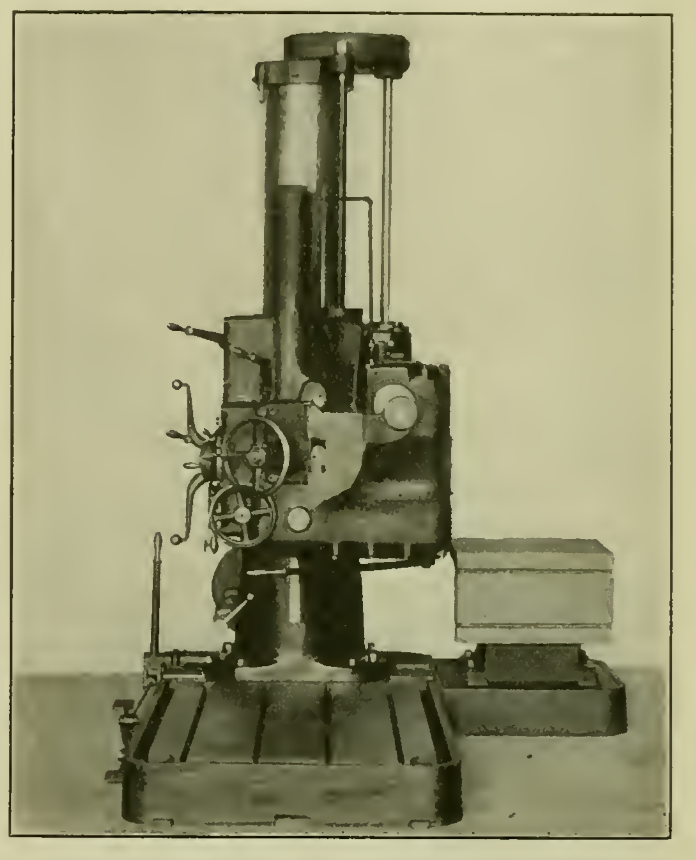
The sleeve for raising and lowering the spindle is mounted at the top of the spindle and balanced by a counter-weight that acts through the same pinion that works the rack for raising and lowering the arm. The spindle has an automatic kick-out for maximum travel up and down.



Belted Motor Drive Through Speed Box on Arm

Power is furnished through a cone pulley, feed change gear box, constant speed drive through speed change gear box, or a variable speed motor mounted on the face and direct connected. This combination of motor drives can also be mounted on the radial arm if desired. The table wing is a separate unit and can be attached to the base at any time. The universal table is furnished as separate equipment and can be provided with a round table which makes it fully universal.

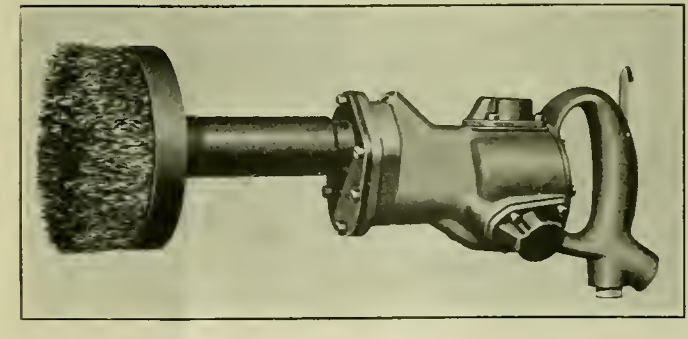
The Carlton radial drill is made in 4, 5 and 6 ft. sizes. It drills to the center of 8, 10 and 12 ft. circles and the maximum distance between the spindle and base is 5 ft., 5 ft. 6½ in. and 6 ft. 3½ in. respectively. The spindle feed in each case is 18 in., a Morse No. 5 taper hole being provided in the spindle. Twelve feed changes are provided arranging for .005 to .069 in. per rev. There are 24 speed changes available varying from 18½ to 800 r.p.m. The working surface of the table and base are 22 in. by 28 in. and 3 ft. 6 in. by 4 ft. 5 in., respectively. Five, 7½ and 10 hp. motors respectively, are required to drive the three sizes.



View Showing Massive Arm and Head, Plain Box Table and Wing

Wire Brush for Cleaning Metal Surfaces

Wire brush cleaning of metal surfaces offers an opportunity for considerable saving of time and labor over that required by hand in removing paint, rust, scale and dirt. It has been difficult, however, to obtain a brush which would work effectively on an air motor and not wear out too rapidly. To overcome this difficulty, a 5-in. brush with special heat treated steel wires has been developed by the Ingersoll-Rand Company, New York. It is sturdily constructed, being designed to stand severe service and is used as an attachment for the No. 6 Little David drill. This drill has liberal bearings to take up all the end thrust, when pressing down on the work and the motor is reliable, operating at high speed. Overall dimensions are small and the brush can be used in sharp corners and other cramped spaces. The total weight is 11½ lb. The brush and motor outfit is adapted for removing paint, rust, scale and dirt from tanks, steel cars, structural steel and all sheet metal surfaces. It is also useful for cleaning iron, steel and aluminum castings, the small heat treated wire points getting into all corners, and removing particles of dirt hard to reach otherwise.



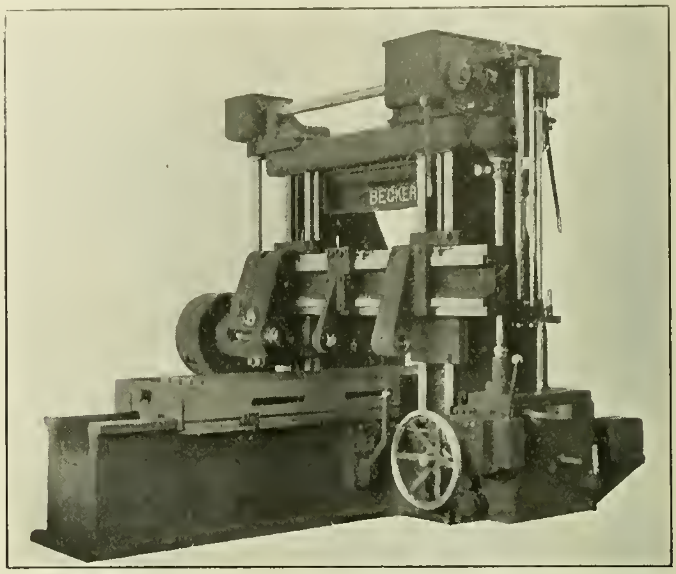
Heat Treated Steel Wire Brush Used with No. 6 Little David Drill

Heavy Planer Type Milling Machine

A LINE of planer type milling machines of the design illustrated is being built by the Becker Milling Machine Company, Worcester, Mass., in widths ranging from 24 to 48 in., and in lengths up to 20 ft. These machines are of heavy construction and are driven through a single-pulley gear box mounted on top of one of the housings. A clutch furnished on the driving pulley for starting and stopping the machine is operated by means of a lever conveniently placed on the operating side. On motor-driven machines, a similar arrangement eliminates the necessity of stopping the motor in order to stop the machine.

Hardened steel gears of the automobile transmission type are furnished and these run in oil. Speed changes are obtained by operating levers located on the side of the right-hand housing. The drive to the spindle is through a bronze worm wheel and a steel worm running in oil. The bed and table are of the box type, heavily constructed to insure rigidity. The table is driven by a spiral worm directly connected to the table rack, this worm also running in oil. The milling head has a hand and power traverse on the rail. The rail is counterweighted and is elevated by power, a fine hand adjustment being provided. This type of machine may also be furnished with two vertical milling heads.

The more general introduction of milling machines into railroad shops has resulted in a considerable increase in machine shop production, particularly when high speed milling cutters are used in a machine of the type illustrated. It has been possible to produce duplicate locomotive parts in a length of time which would have been considered incredible a few years ago. The Becker planer type milling machine is designed to stand up under the heaviest cutting feeds and speeds of which these high speed milling cutters are capable.



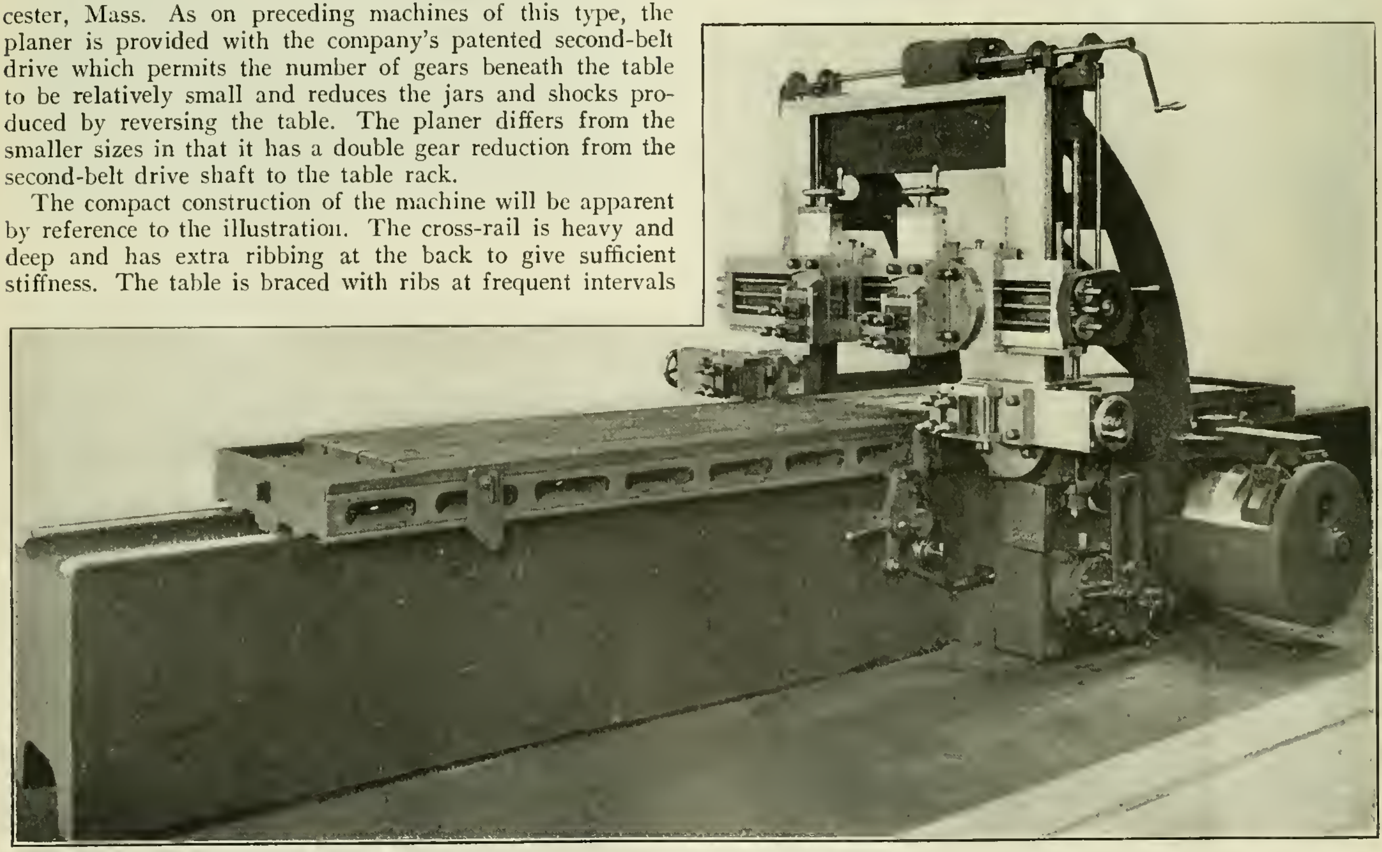
Becker Planer Type Milling Machine

Rugged Construction Marks New Planer

THE 32-in. planer, shown in the illustration, is a recent addition to the line of machine tools built by the Whitcomb-Blaisdell Machine Tool Company, Worcester, Mass. As on preceding machines of this type, the planer is provided with the company's patented second-belt drive which permits the number of gears beneath the table to be relatively small and reduces the jars and shocks produced by reversing the table. The planer differs from the smaller sizes in that it has a double gear reduction from the second-belt drive shaft to the table rack.

The compact construction of the machine will be apparent by reference to the illustration. The cross-rail is heavy and deep and has extra ribbing at the back to give sufficient stiffness. The table is braced with ribs at frequent intervals to guard against possibility of springing. The table T-slot for shipper dogs extends the full length of the table.

Projecting ledges on the under side of the table prevent the



Whitcomb-Blaisdell 32-In. Planer Combining Rugged Construction with Improved Table Drive dropping of chips into the ways. The housings are of the box type, bolted to the bed and rigidly connected at the top by a heavy rail. The bed is cast with a solid top, the only opening being at the center where the double gear reduction is placed. This opening, however, is covered by sheet metal placed in such a way that only the upper segment of the bull gear projects through it. Casting the bed with a solid top serves two purposes, being a safety feature and preventing dirt and chips from entering.

The machine is equipped with a patented cross-rail binder which enables the operator to lock the cross-rail securely to the housings by operating a lever and without moving from his position on the working side of the machine. Patented self-locking shipper dogs are also a part of the regular equipment, it being only necessary for the operator to set these dogs for the required length of stroke. The principal dimensions of the machine are as follows: actual width between housings, 36 in.; planing height under cross-rail, 32¾ in.; length of table, 10 ft.; width of table, 28 in.; length of bed, 16 ft.; length of down feed, 13 in.; and minimum distance between centers of tool-boxes, 7¼ in. The approximate weight of the planer is 17,500 lb.

Improved Tools for Machinists and Toolmakers

Several new and improved tools of value to the machinist and toolmaker have been added to the line made by the Brown & Sharpe Mfg. Co., Providence, R. I. Among these is a depth gage (Fig. 1) primarily important because of its simplicity and accuracy. It is furnished complete with three measuring rods and enables readings from 0 to 3 in. to be obtained by thousandths of an inch, the micrometer screw having a movement of 1 in. The desired rod is easily placed in position by removing cap *A* (Fig. 1), which permits the rod in the gage to be withdrawn and the one desired inserted. Replacing cap *A* brings the shoulder on the rod against a finished seat. The shoulders on the rods are adjustable and permit individual adjustment of any rod. The tool is obtainable with either a 2½ in. or 4 in. base. The same adjustment for wear on the threads is used as is provided on standard Brown & Sharpe micrometer calipers.

An improvement has also been incorporated in the combination squares and sets furnished with centre heads. The centre heads are now ground so that both arms are of equal length and the points *A* and *B* (Fig. 2) are both equidistant from the edge of the scale. This permits the use of centre heads with work of large diameter. The provision of nearly 250 different combination squares and sets affords a broad choice.

A new vernier height gage is shown in Fig. 3. The base is proportioned to give rigidity without undue weight and extends beyond the back of the bar, affording additional stability. The gages are made in two sizes. The 10-in. size can be furnished in either English or metric measure to take inside and outside measurements. It is also made as a combination gage reading to English measure on the front and to metric measure on the back. The 18-in. gage takes measurements outside the jaws. The bar is graduated to read, by means of a vernier, to thousandths of an inch or fiftieths of a millimeter as the case may be, the graduations in each case being carried far enough along the bar to allow measurements to the full rated capacity. The readings with the English measure or metric measure gage are direct and easily legible.

A new vise for toolmakers and mechanics (Fig. 4) is reliable and handy for use in drilling, fitting and laying out work on surface plates. It is case hardened and the base is ground. A large jaw, provided with a tongue which slides in a groove in the base, is held in place by a strap. This feature enables the vise to hold the work firmly and prevents the jaw from lifting. The strap can be removed and by using the jaw upside down, taper pieces can be held in the tool. The greatest capacity of the vise is 2 in. The V-groove in the under side of the base takes work from 9-32 in. to 11-16 in. diameter and thus adds to the handiness of the vise since it can be used as a V block. Each vise is furnished, with two steel jaws which slip on and off the screw to provide for a greater range of work. Fig. 5 shows a pair of vises holding two strips to be drilled with a half hole in each strip, an operation for which the vices are well suited.

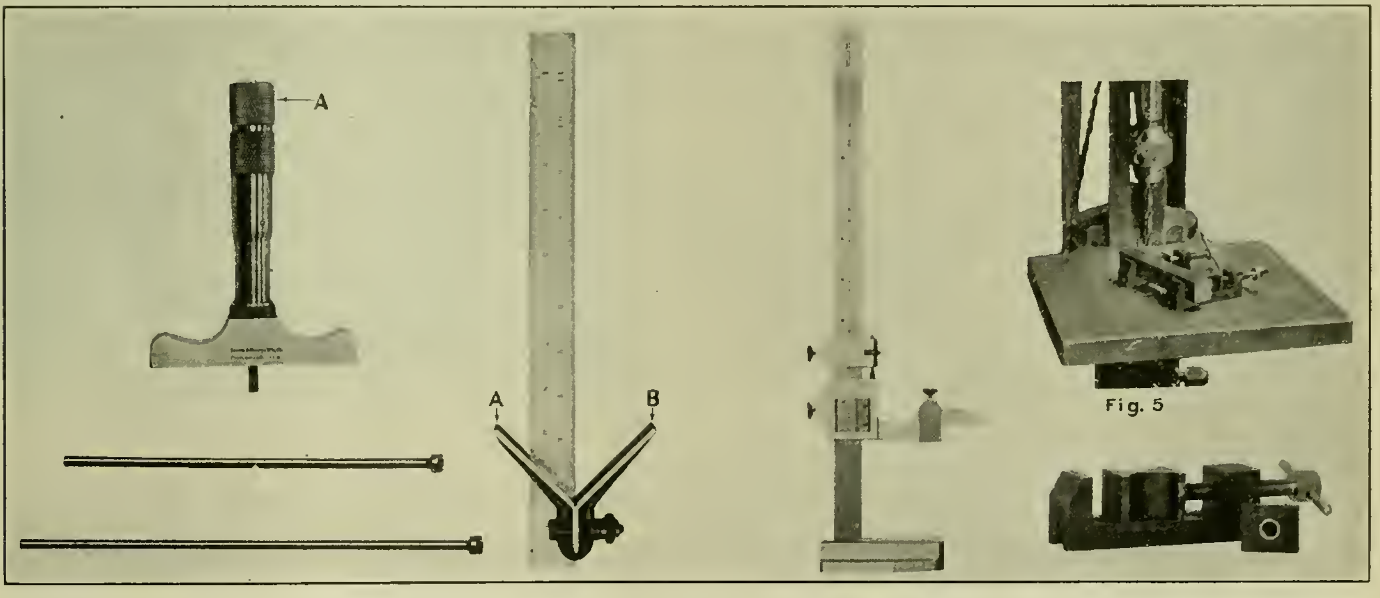


Fig. 1 Fig. 2 Fig. 3 Fig. 4

Recent Additions to the Line of Tools Made by the Brown & Sharpe Mfg. Co.

Electric Grinder and Buffing Machine

THE United States Electrical Manufacturing Company, Los Angeles, Cal., has recently completed the development of a heavy duty electric grinding, buffing and polishing machine. While originally designed for buffing pneumatic truck tires and having an approximate over-all shaft length of 6 ft., the machine is built in a number of different sizes and can be used for many grinding and buffing operations in railway shops.

The spindle of the machine is mounted on standard Hess-Bright ball bearings, which are lubricated by running in a bath of oil. Two of these ball bearings are mounted on the shaft close to the wheels, thus reducing vibration to a minimum. A third ball bearing is located at a proper distance from the other two in order to eliminate periodical vibration which, while not always evident, will cause ball bearings to wear and become loose after being in use only a short time. The diameter of the spindle is 1½ in.

The rotor of this grinding machine is designed and built in such a way as to make it practically indestructible. The rotor bars are brazed to the end rings, making an electrical and mechanical joint that cannot be destroyed except by intense heat, hot enough to melt the copper.

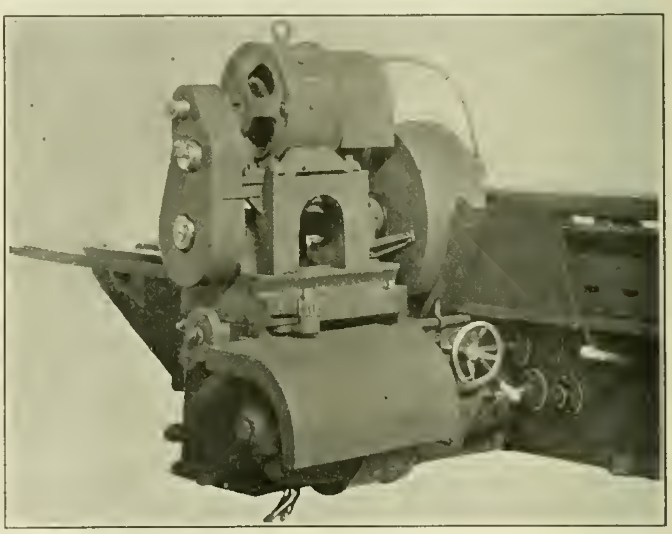
The bearings and windings are entirely enclosed in dust-proof housings to prevent any emery, grit or foreign matter from getting into them. The 5 hp. machine, operating at 3,600 r.p.m. is the most popular size and owing to the combination buffing and grinding feature is a valuable time saver in shops where both operations have to be performed.

Heavy Duty Reversing Motor Face Grinder

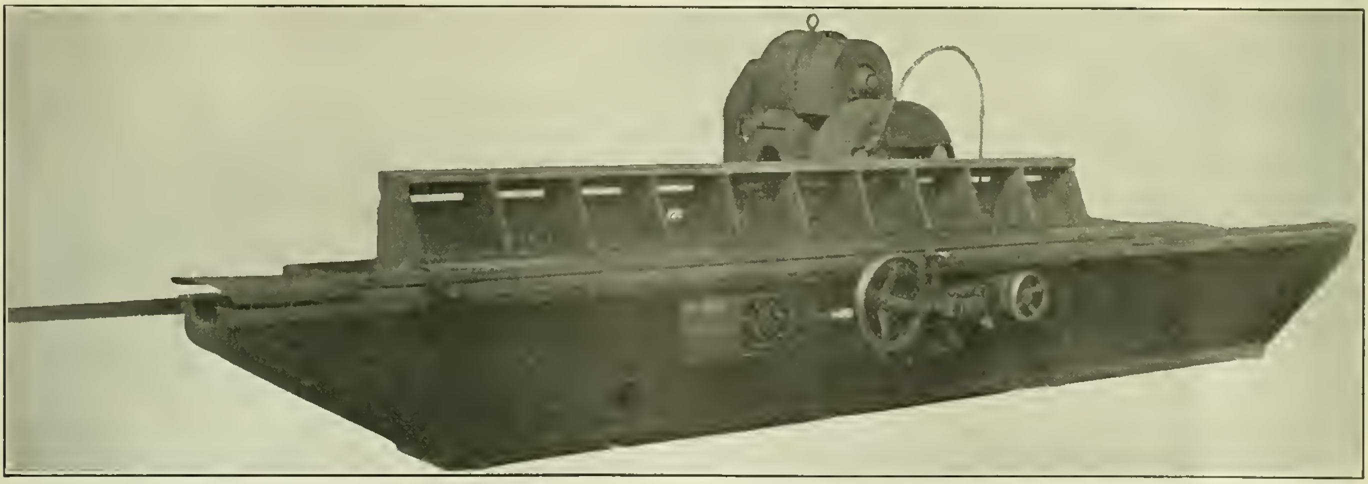
ENTIRELY self contained, the heavy duty grinder illustrated is operated by three motors; one 15-hp. motor for driving the wheel; one variable speed 5-hp. reversing motor for driving the table traversing mechanism, and one ½-hp. motor for driving the pump. The variable speed motor provides a table speed of 7 to 27 ft. per min. and the reversing feature of the motor eliminates all belting. In operation, the machine is controlled from either the front or rear by mechanical means and is also provided with a push button for controlling the motors. The machine, illustrated, has a wheel 24 in. in diameter and has a capacity to grind work 12 ft. long. It is made in different lengths, however, varying from 6 ft. to 17 ft., the weight of a machine of 12 ft. capacity being 14,750 lb.

The advantages of separate motor drive for wheel, table and pump are numerous, perhaps the most important being the greater flexibility in design obtained. There are no unnecessary, power consuming and often dangerous belts and gear trains where individual motor drives for machine parts are used.

This machine can also be furnished with a swivel knife bar making it suitable for grinding large paper and veneer knives and by removing the angle bar shown, it becomes a standard face grinder, adaptable for use on all kinds of grinding within its capacity. The most modern practice of bearing construction, known as the sleeve flange type, is included in this grinder. Bronze bushings are used which can be easily replaced in case of wear and the original alinement not disturbed. The machine, as shown, is arranged for wet grinding and ample provision is made to take care of the spray and drainage. Provision is also made (as shown in the rear view), for swiveling the wheel head by means of a rack and pinion, so as to permit of grinding either straight or concave, as may be desired. The machine is made by the Springfield Manufacturing Company, Bridgeport, Conn.



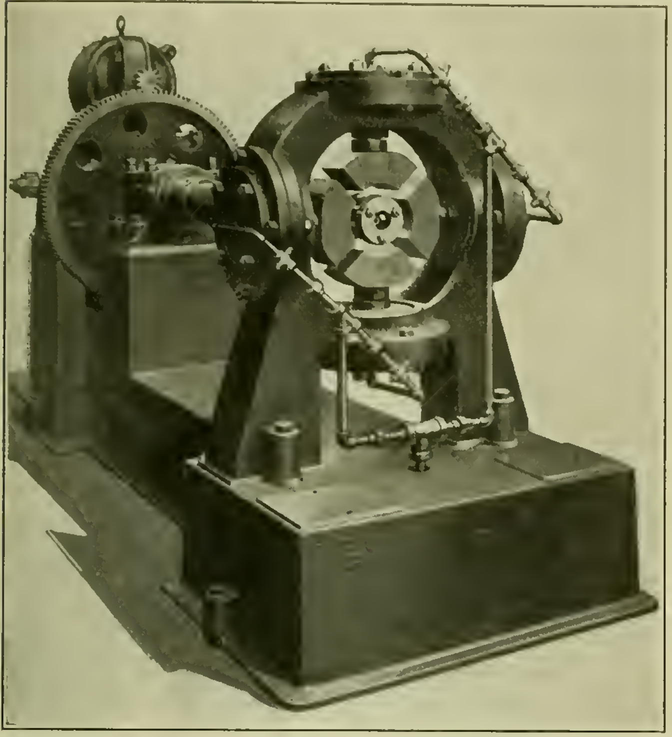
Rear View Showing Motor Drive and Arrangement for Swivelling Grinding Wheel Head



Face Grinder Which Is Entirely Self-Contained, Being Driven by Three Individual Motors

Universal Flue Welding Machine

Perhaps the most distinctive feature of the universal flue welder manufactured by the Southwark Foundry & Machine Co., Philadelphia, Pa., is the fact that it welds the flue on the inside thus making the inside diameter at the weld the same as throughout the flue. This allows a free passage of gases especially in superheater flues, also eliminating the possibility of superheater units sticking in application. The machine is built sufficiently heavy to weld large flues and it takes safe ends of lengths from 6 in. to 4 ft. 6 in. Among the advantages claimed for the machine are relatively small power consumption, closeness of the furnace to the welding head, and a single foot valve controlling all operations.



Front View of Southwark Flue Welder with Heat Deflector Removed

Referring to the illustration the clamping head at the front and the driving mechanism at the back are the two main parts of the machine. Mounted in the clamping head are four air cylinders, arranged for the heads to be removed from the outside. The front ends of the piston rods are equipped with sectional dies to clamp the outside of the flue at the weld. Running through the center of the machine longitudinally is the welding mandrel which fits the inside of the flue. Three rollers are assembled in the body of the mandrel which is hollow. Tapered and free in their bearings, they can be moved radially by inserting the paper mandrel that reaches through the middle of the spindle from the back of the machine. This mandrel is operated by an air cylinder controlled by the foot valve. The unusual length and weight of the safe ends, applied to superheater flues make it desirable to support them while being heated and it is customary to rig up the front of the machine with some type of roller table to support the long flue.

In operation the four clamping cylinders are piped to a single air line and arranged to operate simultaneously with the opening of the single foot valve. This valve is usually placed in front of the furnace on the left hand side, the position, however, being determined by the convenience of the operator. The timing of the different operations is controlled by the piping to the foot valve, so arranged that the clamping head first comes in on the outside of the weld; the jaw clutch which rotates the mandrel is next engaged; and last, the expanding arbor is forced into the center of the three rolls which, being in rotation as part of the mandrel, works the weld out against the clamping dies or anvil.

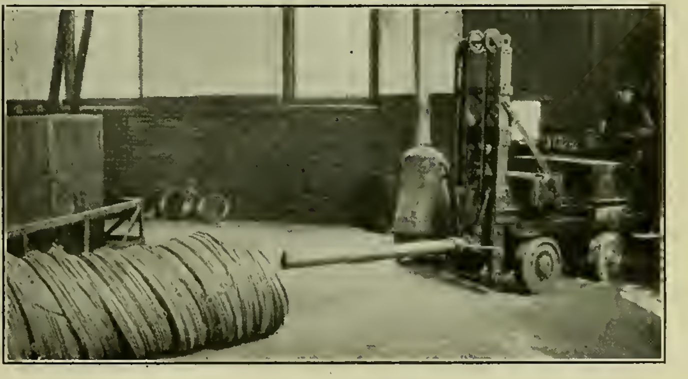
The furnace which should be of the oil burning type is mounted in front of the welding head so that the safe end is supported on the end of the welding mandrel, and a minimum amount of movement of the flue is necessary when passing to the welding position after the proper heat is obtained. The time required for the actual rolling of the weld is from six to eight seconds. The total time of making the weld depends upon the size of flue which in turn determines the length of time required for obtaining the welding heat.

Electric Truck Equipped With Carrying Ram

The illustration shows an electric storage battery truck made by the Baker R & L Company, Cleveland, Ohio, the truck having been recently equipped with a carrying arm or ram which may be elevated or lowered as desired. This feature of the truck was originally developed to enable it to handle the large numbers of heavy iron cores and tire moulds used in the rubber industry. Since each of these moulds weighs several hundred pounds, it is difficult to handle them without machinery but by means of this truck they are readily moved trom place to place as desired.

The truck is sometimes used for carrying coils of wire, as illustrated, in which case the truck is advanced with the carrying ram at the proper level to insert in the inclined pile of coils. The carrying ram is then elevated and lifts the coils from the floor when they can be moved to their desired destination and placed in racks or hung up on pegs. Although developed for the rubber industry alone, this truck has shown that it has quite a wide application, being adaptable to handling material in railroad shops and storerooms.

The mechanism of the truck consists of a carriage mounted on rollers running vertically between channel guides and lifted by an electrically driven cable hoist. The hoist motor is controlled by a small reversing switch, mounted on the dash and its operation in both directions is limited by suitable switches. The truck has a capacity to raise and support a weight of 2,500 lb. when spaced evenly on the ram.



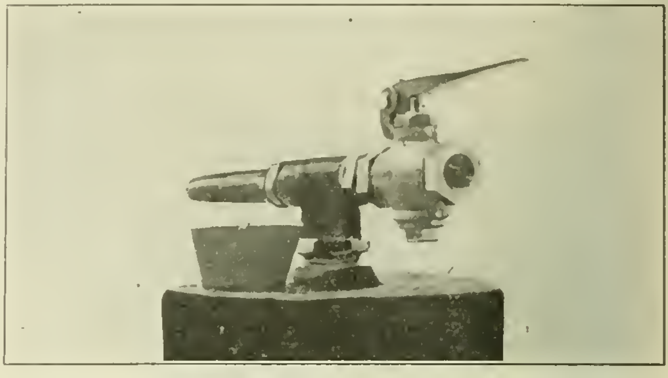
Baker Truck Equipped with an Elevating, Carrying Arm

Portable Device for Sand Blasting

In both electric and oxy-acetylene welding it is important that the parts to be welded be thoroughly cleaned before the welding operation is started. All rust, scale, oil, sand, etc., should be carefully removed. It is also necessary to remove the scale and oxide from the deposited metal from time to time as the weld progresses so as to avoid slag inclusions between the layers. This cleaning work has generally been accomplished by a hammer and chisel or some kind of roughing tool but considerable time can be saved and a better job secured by means of a sand blast. This does not polish the scale on a weld but tends to remove it. A portable sand blast device for this purpose, as illustrated, has been placed on the market by the Transportation Engineering Corporation, New York.

The sand blast consists of a heavy sheet metal tank of about four quarts capacity, provided with a filling hole and an air-operated syphon. The syphon consists of a sand pipe, extending to the bottom of the tank, a pipe tee, an air nozzle, and a sand nozzle. The sand nozzle is case-hardened and is provided with a renewable tip, a trigger valve controlling the blast of sand. An air hose with a 3/8 in. nipple is attached to the open end of the valve, after which the sand blast is ready for use. An air pressure of from 75 to 100 lb. is required for the most efficient operation of this device and a uniform pressure is desirable.

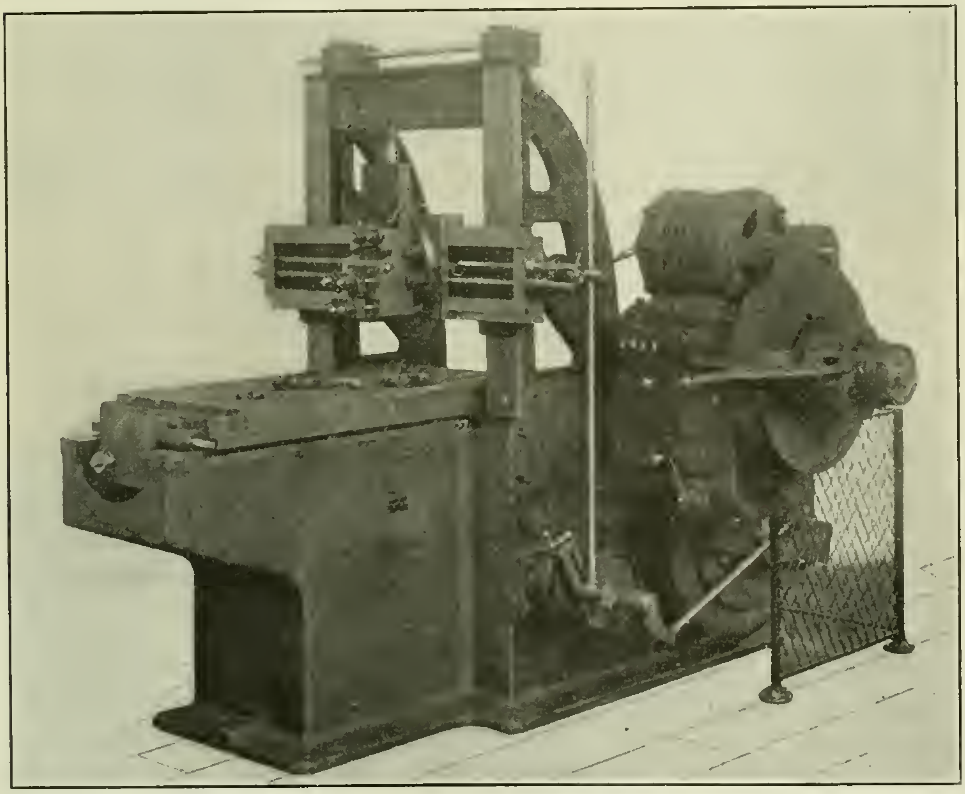
It is claimed that the sand blast will quickly and effectively clean the parts to be welded and also the weld itself, and that it will do this work considerably faster and more thoroughly than is possible by any other means.



Portable Sand Blasting Device Cleans Metal Parts Before Welding

Motor Drive Applied to Crank Planer

For many classes of work the crank planer is superior to either the shaper or belt shifting planer. It combines the rigidity of the planer and characteristics of the shaper, including ability to plane to a line and take the short rapid strokes necessary for short work. The 24 in. by 24 in. by 24 in. crank planer, illustrated, is made by the Woodward & Powell Planer Company, Worcester, Mass., and is particularly adapted to heavy railroad shop work, such as machining die blocks, rod straps, gibs, shoes, wedges, cross-heads, and slide valves.



Woodward & Powell Crank Planer Equipped with Motor Drive

The bed, housings, and cross rail are massive and well ribbed, thus making the machine rigid. The table has large bearing surfaces on the top of the bed, and is gibbed its full length.

The stroke is adjustable for length by a removable crank operating a screw in the crank disc. Any length of stroke up to 24½ in. can be taken over any portion of the table, the position of the stroke being adjusted by means of a shaft on the front end of the table. This adjustment can be made while the table is in motion. The planer can also be furnished with a stroke of 28½ in. if desired.

The housings are lipped on the bed and carried down on the sides of the bed, a construction promoting strength and rigidity. The arch rests on top of the housings as well as between them. The head itself is of practically the same design as those used on previous 24 in. planer models and can be swiveled to either side for angular planing, being graduated in degrees. The cross rail gibs are secured by nuts upon studs, threaded into the rail. The rail screw and rod are squared for the use of a crank at both front and rear ends.

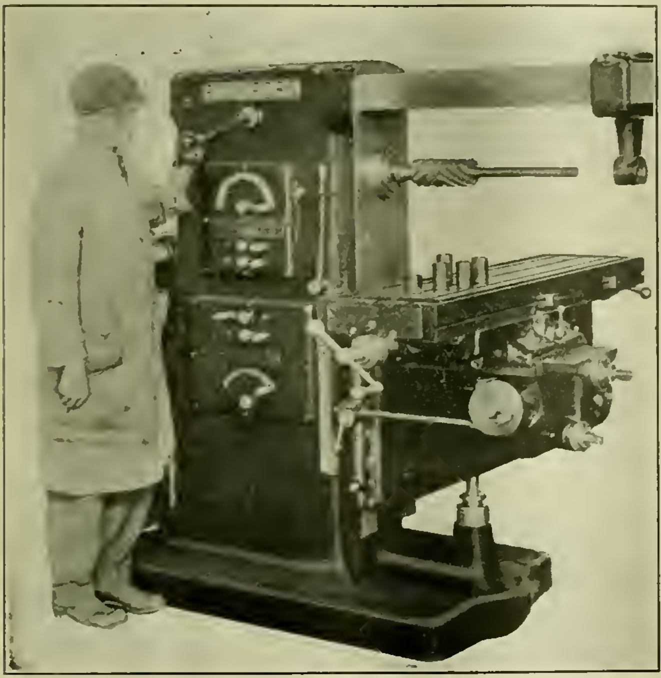
The saddle is lipped over the cross rail and has packing at the top and back of the rail.

The feeds for cross, vertical, and angular travel are operated automatically by power or by hand and, taking place on the return stroke, do not require a longer stroke than is necessary for the cut. The machine can be operated by one pulley connected to a four-speed gear box, or a motor mounted on top of the gear box. Provision is also made for a four-step cone pulley drive in place of the gear box, if desired. The handle for operating the starting and stopping clutch of a gear box driven planer also operates a brake for stopping the table when the clutch is thrown out. All gears and revolving parts are thoroughly guarded by sheet metal cases or wire netting as illustrated.

Work 24½ in. long can be machined on this planer, the height to cross rail and distance between housings being 25 in. Ten, 17, 29 and 48 strokes per minute can be obtained and the ratio of return to cutting speed is 1.4 to 1. A 5-hp. motor is required to furnish driving power.

Milling Machine With Rectangular Overarm

THE Rockford Milling Machine Company, Rockford, Ill., has combined the advantages of previous machines in a No. 3 high power, all geared miller with several new features. The overarm is rectangular in shape, being actuated by a rack and pinion; the speed drive to the saddle and table mechanism has been redesigned to eliminate the telescopic feed shaft and universal joints; and feed and quick return have been combined under a single control. In the new machine, feeds are changed by means of sliding gears instead of the tumbling gear previously used.



Rockford No. 3 Milling Machine with Rectangular Overarm and New Table Feed Mechanism

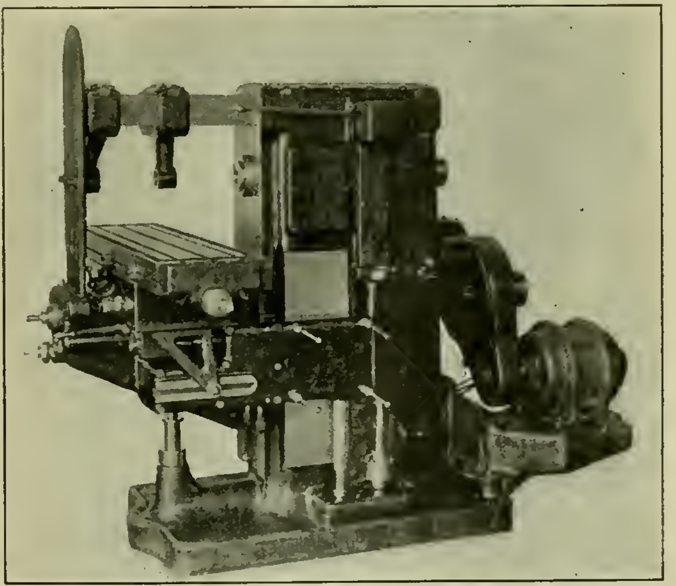
Constant speed drive is secured by means of a 10-hp. motor running at 320 r.p.m, arrangement being made for reversing the main spindle drive. Three levers manipulate all speed variations which are 16 in number varying in geometrical progression from 16 to 422 r.p.m. Twelve feeds are furnished, the range being from 1½ to 16 in. per min. In this case also three levers are used to obtain the feed changes which are plainly indicated on the feed plate.

The overhanging arm is a rectangular cast iron section ½ by 9½ in. It is clamped to the column by means of two securely locked eccentrics. When changing cutters, the eccentrics are loosened and the overhanging arm can be moved out beyond the arbor. The overarm brace is readily removable by loosening the bolt which fastens it to the knee. The center of the spindle is 7¾ in. below the overhanging arm and the maximum distance from the column face to the brace is 25½ in. The working surface of the table regularly furnished with this machine is 15 by 55 in., the range of feeds being 34, 12 and 20 in.

Combination power quick return and feed control is obtained by means of a gear box located on the upper right hand side of the machine. The long lever shown in the illustration controls the table movement. To move the table towards the left the lever is shifted from the center position towards the column and downward. To reverse the movement of the table, the lever is shifted upward into the opposite station. Cross and vertical feed is taken care of in a similar manner, thus enabling the operator to have constant control of whatever feed is engaged. This same lever also controls power quick return for the feeds in all directions.

The knee has the usual long bearing on the column, additional stiffness being provided by means of a heavy support of brace to the column. Both the knee and saddle are arranged to be securely locked and held rigidly when taking heavy cuts. A safety stop for all feeds is provided which acts whenever the load is too heavy, thus eliminating danger of breakage.

A vertical milling attachment can be provided and used without removing the overarm. The plug on the face of the column under the overarm, when removed, exposes the bull drive gear into which is inserted the geared drive shaft for the vertical attachment. By clamping the vertical attachment to the extreme end of the overhanging arm as well as to the flanges of the column, the attachment is in position for operation.



View Showing Motor Drive Arrangement

The floor space required for the machine is 126 in. parallel with the spindle and 116 in. at right angles to the spindle. The machine has a net weight of 7,270 lb.

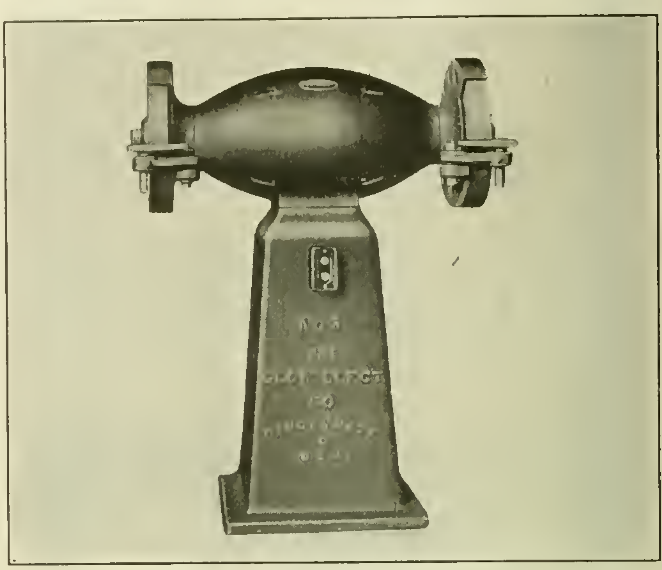
Double Annular Ball Bearing Floor Grinder

THE fact that the No. 3 electric grinder and polishing lathe, illustrated and made by the Glow Electric Company, Cincinnati, Ohio, is totally enclosed makes it especially adaptable to use in railroad shops, most of which are extremely dusty and dirty. The machine is made fully enclosed and dust proof and there is practically no possibility of abrasive dirt or dust getting into the bearings. External grease cups or oil gages have been eliminated and the oil wells are filled with a special evaporated oil which insures adequate lubrication for a period of at least a year. The recharging of the oil wells is a simple matter and in some cases the original supply of oil has lasted for almost two years.

The machines are driven directly by alternating current or direct current motors running at 1800 r.p.m. These motors are so designed as to take care of large overloads with small temperature rise. Two annular ball bearings (without a filling slot) of large diameter, having a spacing sleeve between, are used on each side. The bearings are of such a size as to withstand double the load for which the wheel is rated.

The inside wheel flange is keyed to the shaft with a Woodruff key, only a small clearance being allowed and this prevents dust from getting into the bearings, or oil from getting out. There is another dust collar between the inside flange and the other ball bearing, thus affording additional protection. The symmetrical contour of the frame gives large clearance and makes the machine easy to keep clean. Adjustable work rests are provided as shown in the illustration.

The 3, 5 or 7½ hp. sizes are furnished for floor mounting with standard starters or switches concealed inside the pedestal as standard equipment. These same sizes can be furnished with push button controller if desired. In the smaller sizes the switch is mounted in the frame of the motor.



No. 3 Electric Grinder and Polishing Lathe

Single and Double Spindle Threading Machines

TWO new threading machines, brought out by the Eastern Machine Screw Corporation, New Haven, Conn., embody high rates of production and quality of the work. Special features include hardened and ground spindles and round tool steel ways with bronze bearings, easily replaced when necessary. The design of the slides is such that the piece threaded is held low and near the slide bearing. This does away with cross strain and cramp and makes accurate alinement possible under all conditions.

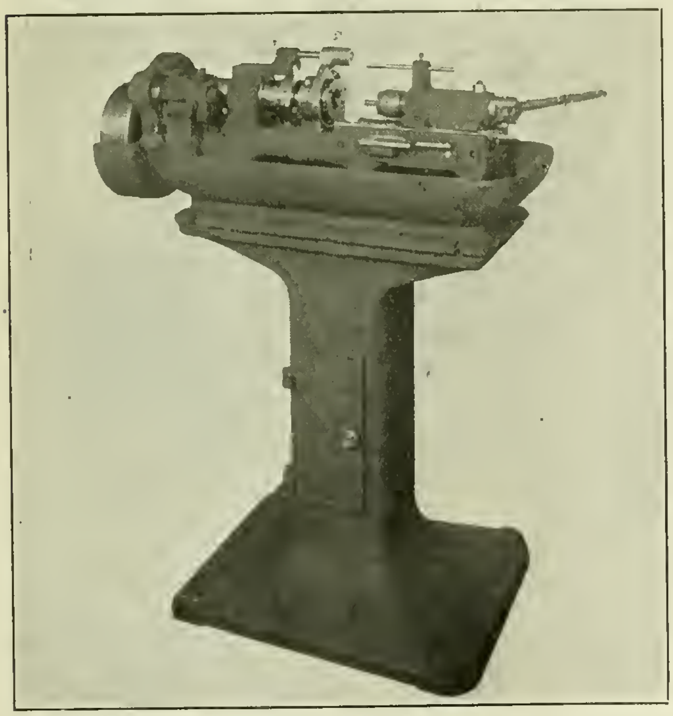


Fig. 1—H & G Single Spindle Threading Machine, Model SS

Although designed with liberal margins of safety the machines are relatively small and compact for the range of work and rate of production of which they are capable. Only a relatively small floor space, therefore, is occupied.

Single Spindle Model SS Machine

The small bench threading machine has been recently re-designed, as illustrated in Fig. 1, with the purpose of improving its appearance and durability and enlarging its range of work. This machine may be obtained either as a bench machine or equipped with a cabinet base. The bench space taken up in the former and the floor space in the latter are small. The slides while regularly equipped with spring collets may be furnished with an open side jaw where the shape of the work is such that this method of holding is more desirable.

An automatic stop provides for holding the work at the same point with each piece threaded and an easily adjustable tripping arrangement insures the proper length of threading cut on each piece. An interesting feature in connection with the open side jaws is that the operator will use only one hand to close the jaws, feed forward the work, draw back the work and open the jaws. Equipped with a pump which may be instantly made right or left hand, the machine is capable of threading either right or left hand threads by simply changing chasers and reversing the belt. The hollow ground spindle permits threads to be cut up to 9¾ in. in length whereas the side open jaws provide for holding stock of any length required.

Production with this machine should range from 300 to

1,000 pieces per hour, depending upon the class of work, and it can be operated with practically unskilled labor. The machine is equipped with H & G die heads and will accommodate any size of head up to 1¼ in. capacity, cutting pitches as coarse as 11.

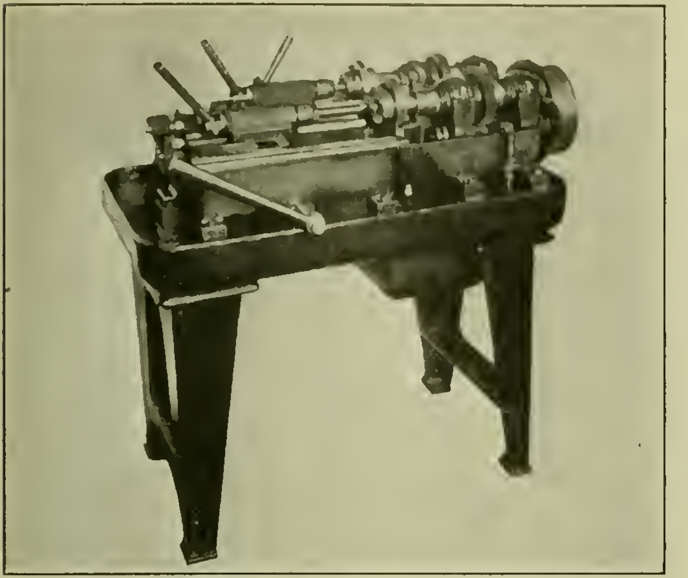


Fig. 2—H. & G. Double Spindle Threading Machine, Model DS

Double Spindle Model DS Machine

To provide a threading machine of greater capacity and maximum rate of production, the double spindle H & G threading machine illustrated in Fig. 2 has been developed. The different gear ratios make it possible to operate always at the most efficient speeds and with one operator handling two spindles the cost of threading is reduced to a minimum. The height of the machine from the floor to the spindle is 38 in., the overall length and width being 45½ in. and 29⅜ in., respectively, and the gear ratios are 9:1, 6:1, 3:1, 1½:1 and 1:1. The bearings are of bronze tapered and readily adjusted. Take-up bushings allow for wear of the spindle. Hardened round tool steel ways are provided; also bronze bearings in the slides. The pump (chain driven) runs at one speed regardless of the spindle speed: oil is pumped through the spindle into the die head. A 10-in. diameter pulley carrying a 3-in. belt drives the machine. Slides are regularly equipped with spring collets and are moved by a lever through a rack and pinion. They are designed so that any form of work holder may be readily attached. Open side jaws with an automatic stop for the length of work, to be operated by one lever for each slide, may be furnished. The machine will cut any thread within range of the 9/16 in., 1 in., 1¼ in. or 1½ in. H & G die head used.

Twenty-One Inch Heavy Duty Upright Drill

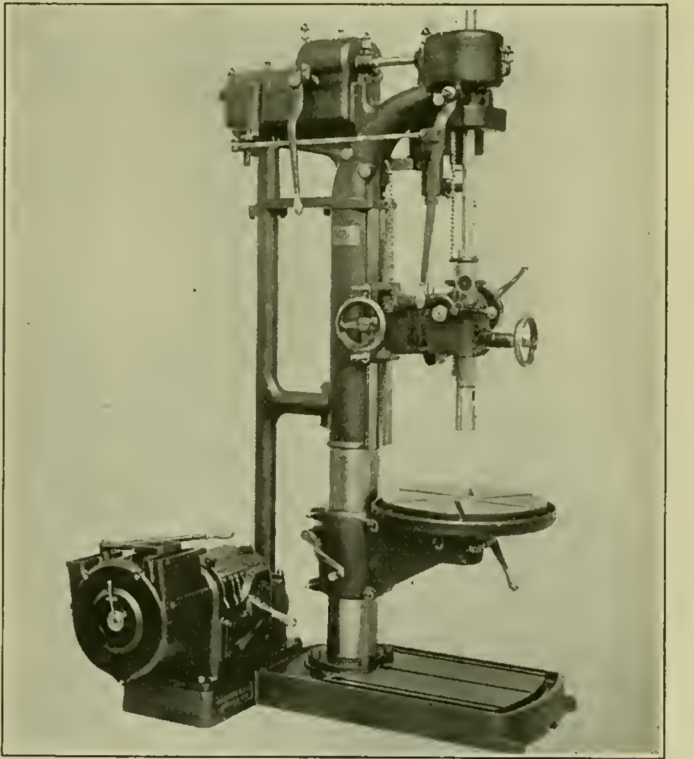
The Fosdick Machine Tool Company, Cincinnati, Ohio, announces an addition to its line of drilling machines in a new 21 in. heavy duty drilling and tapping machine. This drill is of unusually massive proportions and will drive a 2½ in. high speed drill through steel and a 3 in. pipe tap in cast iron. The machine is ordinarily driven by a constant speed belt to tight and loose pulleys on the speed box. This gives a wide range of speeds at the spindle arranged in geometrical progression from 49 to 550 r.p.m., suitable for driving all sized drills from 3/16 in. in diameter up to 5 in. for boring.

Large numerals over each position of the speed changing lever indicate the revolutions per minute of the spindle, while the corresponding metal plate on the head indicates the proper speeds and feeds for various sized drills for high speed drilling in iron or steel. Each machine is equipped with an improved tapping attachment controlled by a lever near the spindle head which instantly starts, stops or reverses the spindle. There are five geared feeds ranging geometrically from .004 to .028 in. per revolution of the spindle.

An automatic trip and depth gage may be set to the graduated scale to stop the feed at any desired depth. This is accomplished without dropping or disengaging the feed worm, which permits continuation of the handwheel feed after the power feed has been tripped. The handwheel feed may also be fed ahead of the power feed without disengaging the latter, which is particularly advantageous in starting large drills.

The spindle quick return is of the expanding ring friction type and operates also without disengaging the feed worm. It serves as a hand lever for sensitive drilling, for tapping, for rapid raising or lowering of the spindle and for engaging and disengaging the power and hand feeds.

The machine may be driven by a constant speed motor geared or belted to the speed box, or by a 3 to 1 variable speed motor which eliminates the speed box. All styles of drives are interchangeable. The machine drills to the center of a 21 in. circle; has a distance of 49½ in. from the base to the spindle, and a base working surface of 19 in. by 20 in. The table diameter is 17 in. and the distance from the table to the No. 4 Morse tapered spindle, which has a traverse of 11 in., is 33 in. The sliding head traverse is 22 in., the column diameter, 7 in. and the net weight 2,100 lb. These machines are also furnished as gang drills having from two to six spindles, and various types of tables, bases and drives.



Fosdick 21-In. Heavy Duty Drill

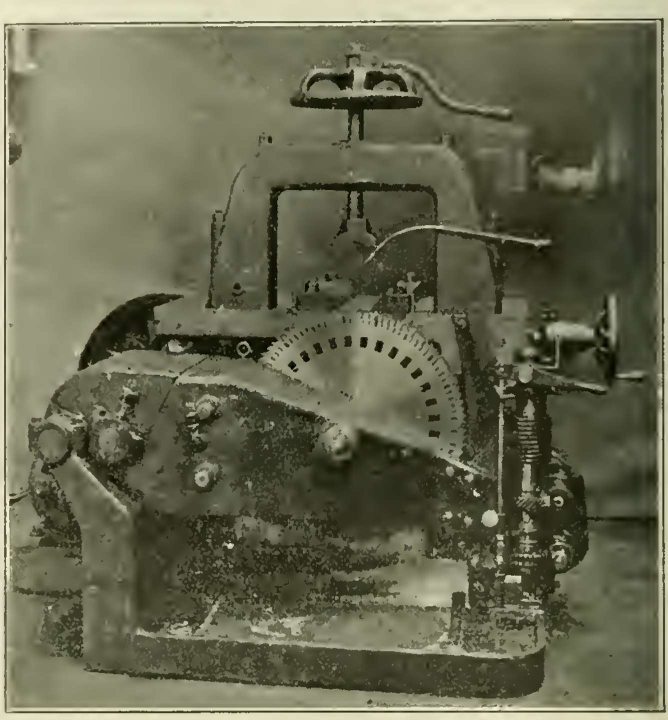
Cold Metal Saw for Heavy Duty

MANY valuable features are included in the No. 26 Lea-Simplex cold metal saw, illustrated. This machine has been developed by the Earle Gear & Machine Company, Philadelphia, Pa., for cutting high grade alloy steel, gear steel, etc. Particular attention has been given in the design to secure a machine able to stand up under the heaviest cutting feeds and speeds of which inserted tooth high speed saw blades are capable.

Arrangements are made for quick preparation of the cut, rapid location of the blades, maximum cutting speed, fast feed and automatic stops, with power return of the blade upon completion of the cut. The clamping fixtures are convenient, the clamp screw being tightened by means of a detachable clamping lever. T-slots in the table permit holding the stock at any desired angle. The machine cuts large stock, using exceptionally small blades with resultant economy in power and material. Combined hand and power advance is provided; also power return. A tripping device will stop the advance at any pre-determined depth of cut. The saws are built with quick change gear feeds, the feed varying from ½ in. to 1½ in. The rate of feed can be changed while the saw is cutting.

The saw blade is supported at only three points, being guided and pulled through the work (not pushed) with a steady motion free from jerks and jolts, resulting in a smooth cut surface. The blade is fed upward into the stock and, therefore, does not touch the work at an angle even if an angle cut is to be made. There is no tendency to crowd the blade away or distort it; hence angle cuts can be made with great accuracy. Centralized control is provided and all operating levers can be reached from one point. One attendant can operate several machines by using the automatic stop and high priced operators are not required.

Simplicity, rigidity, durability, compactness and flexibility are features claimed for the No. 26 Lea-Simplex saw which is said to be equally efficient when cutting solids, structural material, soft steel, tool steel, cold rolled shafting, copper billets, brass ingots, rails, etc. Round stock up to 11 in. in diameter, square stock up to 10 in. square, flat and structural shapes equivalent to 20 in. I-beams can be cut. The work table is 22 in. by 44 in. by 35 in. high. The space under the clamp yoke is 14½ in. high by 18½ in. wide. The machine weighs about 4,500 lb. and requires a floor space 60 in. by 72 in. A 24-in. driving pulley with a face 6 in. wide, running at 115 r.p.m. is required.


No. 26 Lea-Simplex Cold Metal Saw

Roller Bearing Featured by Staggered Rolls

STAGGERED roller bearings, manufactured by the Hart Roller Bearing Company, Orange, N. J., represent a distinct departure from the conventional roller bearing design in that they employ a series of short rolls, staggered about the periphery of the raceway, as an antifrictional method of efficiently carrying large radial loads. These rolls are made of high carbon, high chrome steel, hardened and ground, and operate between two raceways of the same material. The rolls are mounted axially on steel cage pins, with a suitable running clearance, determined by design proportions, and practical experience. The cage pins are riveted to steel end rings and the rings, pins and rolls constitute the roller assembly which operates between the raceways. This form of bearing construction is said to provide freedom from roll breakage, maximum load carrying capacity, excellent lubrication and long life.

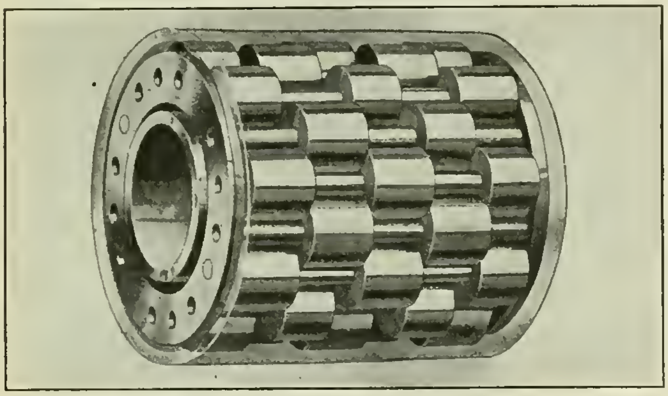


Fig. 1—Hart Staggered Roller Bearing

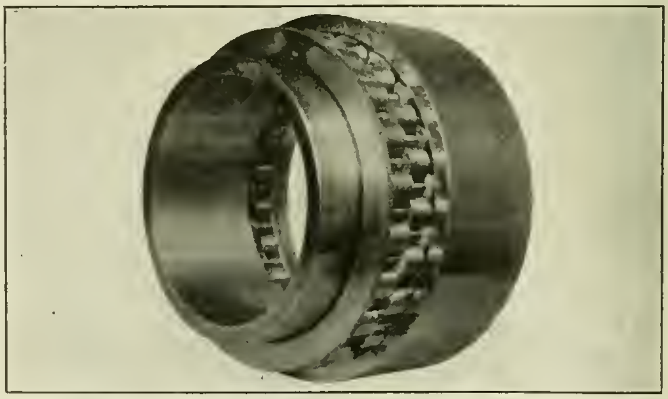


Fig. 2—View Showing Inner Race, Staggered Rolls and Outer Race

In roller bearings having a series of long, continuous rollers it is difficult to grind true cylinders without taper. Also, there is danger of roller warpage during heat treatment.

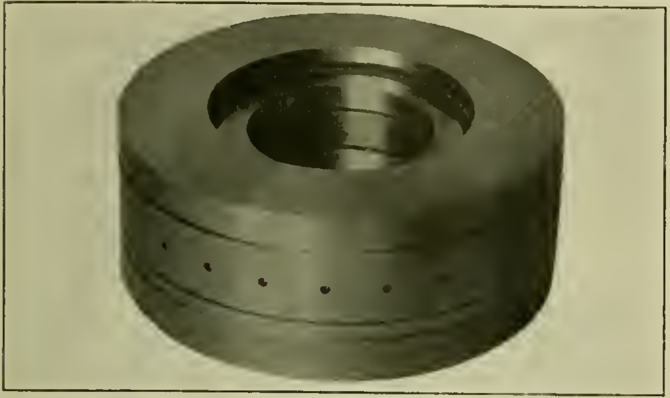


Fig. 3—View of Assembled Thrust Bearing

Other things being equal, the roller warpage varies practically as the ratio of the length to the diameter of the rollers and it is obvious that in short rolls, with the diameter approximately equal to the length, warpage is reduced to a minimum. Long rollers, due to warpage, possess an inherent misalinement and, when a load is applied to the bearing, frequently tend to skew diagonally with the races. This tendency is accelerated by the running clearance provided for successful operation and the result, frequently, is roller breakage. By employing a series of short rolls the skewing tendency is so small that the rolls adjust themselves to such variations.

An additional advantage of staggered rolls is their more equal distribution of the load. They present a multiplicity of raceway supports and adjust themselves absolutely to that portion of the raceway which they carry. The result is a maximum utilization of roll length for load purposes, incident to full line contact on each roll in the load zone. This staggered construction permits of maximum load carrying capacity per unit length of roll.

Spaces or pockets between the staggered rolls serve as oil reservoirs which feed lubricant zig-zag to the periphery of the rolls, to the space between the rolls and cage pins, and to the faces of the cage rings. All contact surfaces are thoroughly and automatically lubricated, the rolls themselves giving the lubricant mass such a motion that it distributes itself adequately to all vital points.

Drilling Machine With Nut Facing Fixture

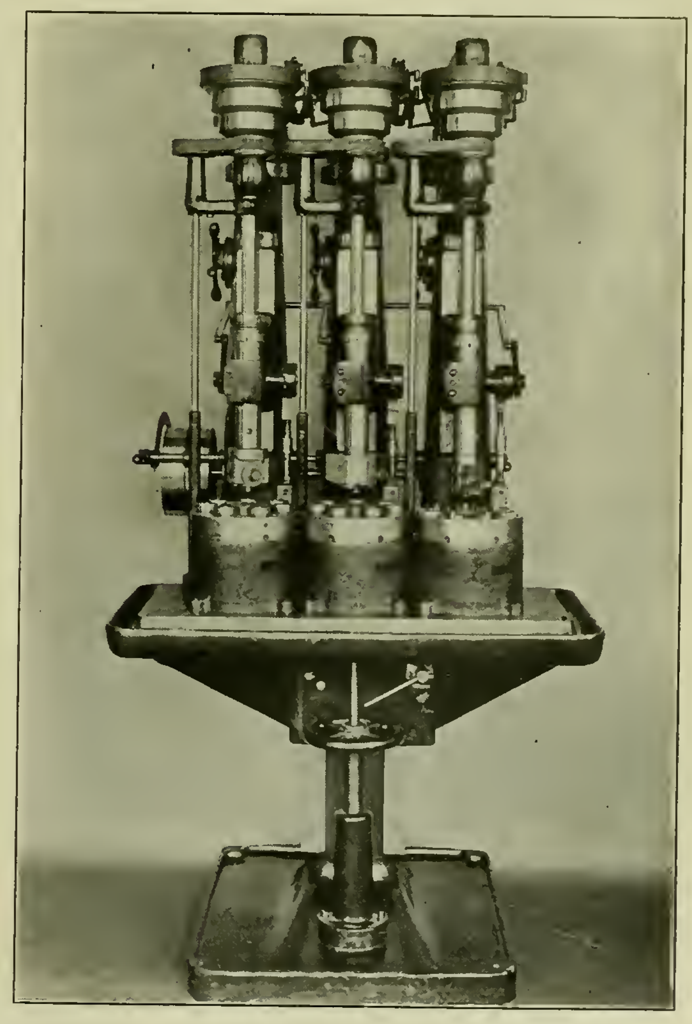
THE drilling machine fixtures, illustrated, are used for facing the top surface and the bevel of hexagon, cast-brass and valve packing nuts, and will accommodate nuts from 1 in. to 2¼ in. across the flats. The fixtures operate automatically, and are attached to a three spindle drilling machine, manufactured by the Edlund Machinery Company, Cortland, N. Y.

The machine is furnished with a standard drive, using four-step cone pulleys. The available spindle speeds are 510, 816, 1,273 and 2,038 r.p.m., with the drive pulley running at 500 r.p.m. The highest of the spindle speeds (2,038 r.p.m.) is too fast for the requirements of the job for which these fixtures are intended. Consequently the high speed step of the front cone pulley is utilized to furnish the power by means of which the automatic fixtures are operated. Extra large spindles are fitted to the machine, which are equipped with plain hardened steel and bronze thrust bearings at the lower end, for the purpose of taking the cutting thrust, ball thrust bearings at the upper end being provided to support the weight of the spindle when running idle. It is necessary to remove about 1/16 in. of material in the facing operation and the resulting finish must be smooth and free from chatter marks.

The automatic fixtures consist of a revolving work-table, indexed by a cam carried by a camshaft located at the rear of each fixture. This camshaft, which cannot be seen in the illustration, is driven by worm-gearing, the worm being attached to the vertical shaft which takes its power from the lower step of the front cone pulley. The cam, by means of which the spindle is fed, is designed to approach the cut quickly and then feed to the desired depth, allowing the tool to revolve several times after the facing operation is complete so as to give a smooth finish. The spindles are fed down against the tension of long helical springs and after the feed is completed the spindles are returned by the pull exerted by these springs. A safety device has been incorporated in each fixture which makes it impossible for the table to be indexed until the spindle is at the end of its stroke.

The operator's only duty is to load and unload the fixtures which can be done while indexing or during the cut.

The production time for 1-in. nuts is 1,000 per hour when all fixtures are in operation on the same size. The spindle speed is 1,273 r.p.m. in this case, and the feed 0.006 in. per spindle revolution. For large nuts 2¼ in. across flats, the possible output is said to be 420 faced nuts per hour.



Edlund Drilling Machine Equipped with Nut Facing Attachments

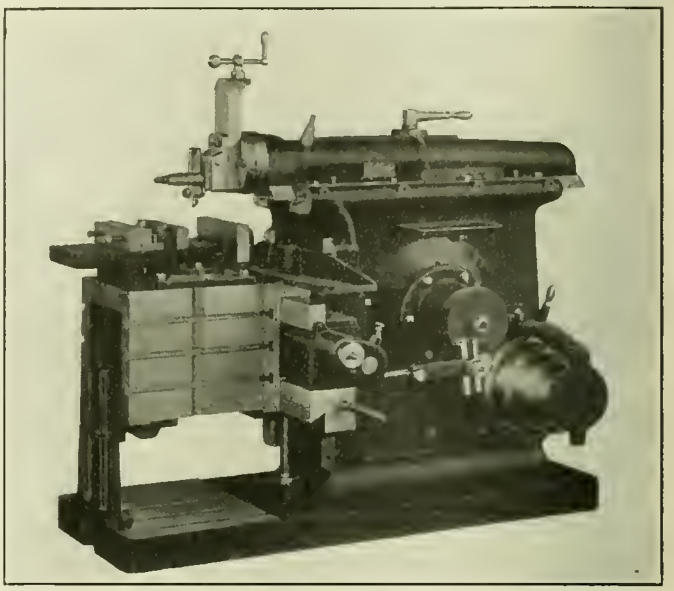
Cone or Single Pulley Driven Shaper

A LINE of shapers, built in five sizes with strokes of 12 in., 16 in., 20 in., 24 in., and 32 in., respectively and arranged for cone pulley or single pulley with gear box drive, has been placed on the market by the Bertschy Engineering Company, Cedar Rapids, Iowa. The column of the machine is designed for strength and rigidity, being maintained in alinement with the base by means of a tongue and groove. Referring to the illustration, it is evident that the base extends beyond the sides of the table and around the column thus affording a substantial foundation.

The hub bearing of the semi-steel bull gear is supported by a flanged bushing firmly secured to the column. The rocker arm is mounted on a counter-weight held in the column and extending into the base. Forty-five deg. V-ways are provided for the ram, only one adjusting gib being necessary. The ram can be positioned while running by means of the adjusting screw illustrated. The weight of the swivel head is carried by a large plug bearing in the ram head, the tool box being similarly mounted. Micrometer adjustments can be made by means of the dials on all cross and down feed screws.

The cross rail is held by tension bolts when the locking bolts are loosened. The elevating screw is operated by means of a train of bevel gears, mounted on ball thrust bearings. The table is of substantial construction as shown in the illustration and is provided with T-slots cut from the solid metal. A tongue and groove arrangement holds the table in alinement and braces at the outer end are arranged to support it when taking heavy cuts. A friction safety device on the power crossfeed prevents damage due to feeding beyond the limits of the machine.

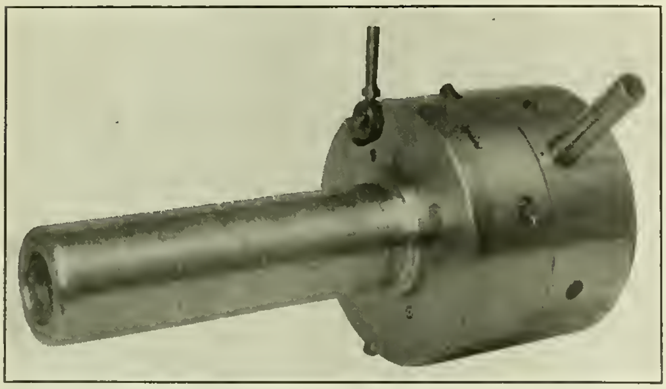
When provided with cone pulley drive, no outer bearing is needed since the pulley runs on a large sleeve mounted on the column. With single pulley drive, a gear box having a train of heat treated alloy, steel cut gears is provided. Four changes of speeds, with two ratios in the bull gear train, make a total of eight available speeds. When desired the machine can be arranged for motor drive through a silent chain.



Bertschy Cone-Driven Shaping Machine

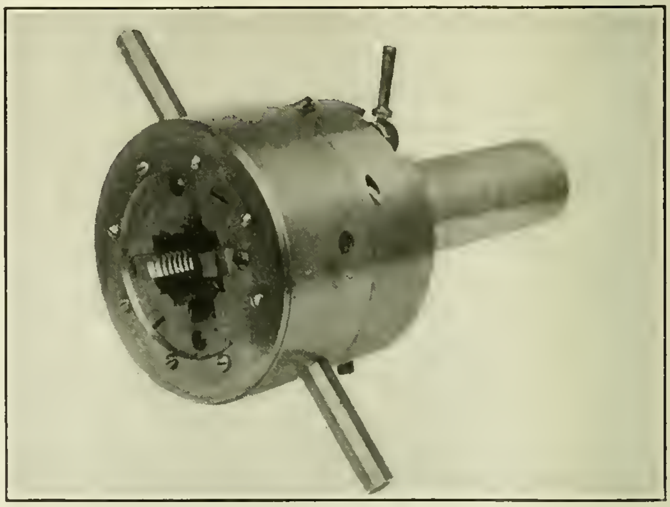
Self-Opening and Adjustable Die Heads

SUPPLANTING its Style B self-opening, adjustable die heads, the Modern Tool Company, Erie, Pa., has developed a Style H die head for hand or automatic screw machines. This head is made up to and including size No. 5 which has a capacity of 1 in. to 2 in. The Style H die heads are designed to cut any thread right or left and any form of pitch. Each head will cut every diameter within its capacity and the threading may be done to any length the turret travel will permit. Straight or taper threads may be cut the full length or close to the shoulder. A special feature of the Style H head is a "float" which compensates for the drag of the turret.



Modern Style H Self-Opening Die Head

The die head chasers are supported at the outer edge by a cam ring, making it practically impossible for chasers to change position during the work. This is an important advantage resulting in accurate work and smooth threads. The chasers are hobbed and held in chaser blocks with screws. These chaser blocks fit in T-slots in the die heads and are rigidly supported at the outer end by a cam ring which holds the cutting points of the chaser in the proper relative position. Coil springs hold the chaser blocks against the cam ring in conjunction with screws through the ring. By removing these screws the chaser blocks may be taken out for cleaning without disturbing any other parts.

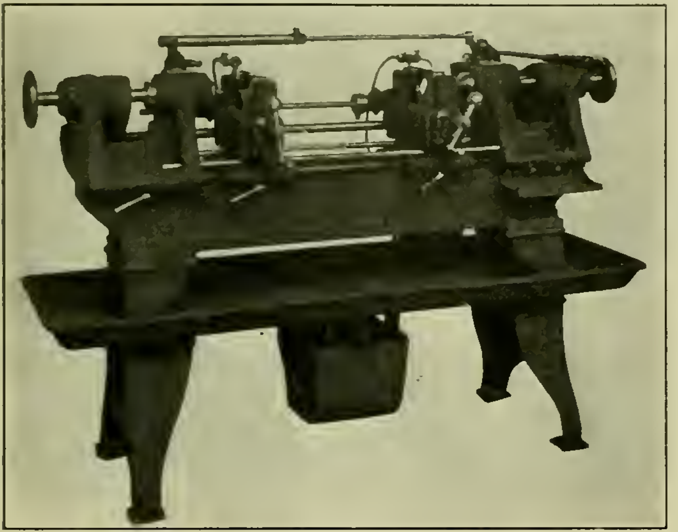


Another View of the Style H Die Head

Micrometer adjustment is provided on the head for changing the position of chasers in case threads are too tight or too loose. The die heads are mounted on shanks which are made hollow for threading long pieces. The dies open automatically when the turret travel ends or may be opened at any point by stopping the feed. An internal trip may be installed when ordered. Dies may be closed by handles on the side or by a closing pin set for contact with the turret slide as the turret turns to the operator's position. The new style H head also has a roughing and finishing attachment incorporated. Special ring closing, taper threading and yoke closing attachments are available if desired. A special base plate also is made when it is desired to attach the die head to hollow hexagon machines.

Double Spindle Centering Machine

Made by the Hendey Machine Company, Torrington, Conn., the double spindle centering machine, illustrated, was designed to meet the requirements for accurate centering and ease and quickness of handling. The headstock casting is large, being so made to accommodate ball bearings for the spindle. The rear housing is fitted with two radial thrust type ball bearings which carry the sleeve of chain drive sprocket. The spindle is free to slide in the sprocket sleeve and is driven by a key in the spline. The front housing carries a sleeve with a taper bearing which furnishes a satisfactory method of taking up wear on the spindle.



Hendey Double Spindle Centering Machine

A locking pin for the spindle is applied to the head casting but is always held in "out" position by means of a spring so that when it is desired to loosen the chuck by means of the draw-in hand wheel, the pin must be manually held in engagement with the spindle. As the pin is released when the operator is finished there is no danger of its remaining locked with spindle due to oversight. The accuracy of alinement of the jaws is such that finished work can be centered to within .001 in. with an eccentricity which will not exceed .002 in.

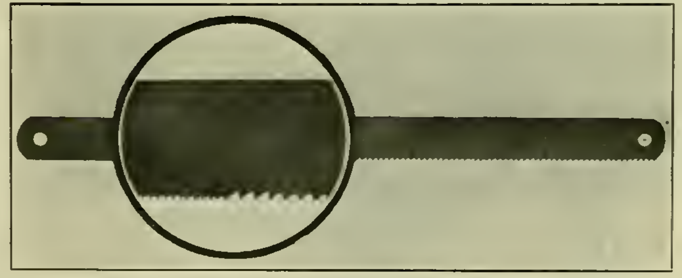
The saddles of the vise blocks are well proportioned, having a bearing length on bed of 7 in. Binding handles give quick release and lock when a change of position is necessary. Simultaneous movement of vise and support is maintained by means of a connecting rod and beveled gear drive controlled from the one ball handle at the front of the vise.

The power shaft is supported in sliding pillow blocks, so arranged as to secure necessary tension on a chain drive. Both chain drive and driving pulley are completely guarded. The machines may be readily adapted to motor drive, and for this purpose a pad to receive the motor bracket is cast on the rear side. Motors of approximately 1/6 hp. and with a speed of 1,200 to 1,500 r.p.m. are recommended as a satisfactory power unit for the single head machine, while a ½ hp. motor will be ample for the double spindle machine.

Hack Saw Blade With Fine and Coarse Teeth

The Peerless Machine Company, Racine, Wis., has developed a duplex hack saw blade with fine 32-point teeth at the toe and coarser 16-point teeth on the rest of the blade. The advantages of this design in starting a cut are obvious since the fine teeth at the toe cut easily and true at slow starting speed, preparing the way for faster cutting as the coarse teeth on the rest of the blade enter the work. Cuts can be started on sharp corners without adhering to the bad practice of drawing the blade backward over the work. With duplex blades, the fine teeth at the toe take hold of sharp corners without chattering or jumping sideways, producing an accurate cut and eliminating shelled teeth and broken blades.

Peerless duplex blades are made in two types; all hard tungsten steel and flexible carbon steel. The former, correctly hardened and tempered, are especially adapted for use by toolmakers in cutting tough steels and by mechanics for general use. The cutting edges are hard and tough, and stand up well on difficult sawing jobs. The carbon steel flexible type is hardened on the tooth edge only, the remainder of the blade, being toughened to prevent excess stretch when tensioned. It is able to withstand severe usage without breaking. In electrical and steam-fitting work, or in other trades where the material to be cut is of a thin, irregular section, and where the work cannot be held rigidly in a vise or reached from an easy sawing position, the duplex hack saw blades offer valuable assistance. They are made in 8- 10- and 12-in. lengths, being ½ in. wide and .025 in. thick.



Peerless Duplex Hack Saw Blade

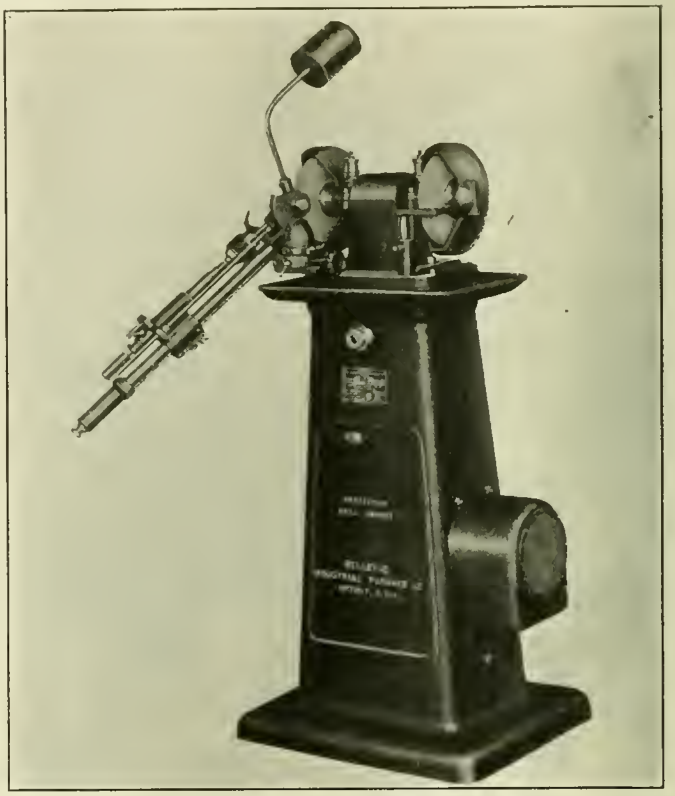
Semi-Automatic Twist Drill Grinder

The drill grinder illustrated is automatic in the actual sharpening of drills, but semi-automatic in the general movement of the mechanism. It will sharpen a 2, 3 and 4 lip right or left hand drill theoretically correct and in an extremely short time. In operation the holder arm is held in a horizontal position by means of a counterbalance. The drill, if a taper shank, is placed in the holder or spindle direct and, if a straight shank drill, is held in a suitable chuck. The holder with drill is then brought forward to meet the drill point gage, which indicates the proper distance to the grinding wheel face as well as the right height of the drill lip, in order to obtain the correct angle of the extreme point. The arm is swiveled to the angular stop and while held against this stop, the arm is being moved down and up several times, the finishing cut being downward only. After one lip is thus ground the drill spindle is then indexed to the next lip and the operation repeated as previously explained.

The rotation and oscillation of the drill is controlled by the upward and downward movement of the arm. This movement, a semi-automatic action, gives the drill a convex backing of the lip and consequently a long cutting life as well as smooth production. A cross feed movement is also provided so as to make possible the use of the full face of the grinding wheel. This is also used for truing the grinding wheel.

The machine is being built in two sizes, one size to grind drills from 1/16 in. to 1½ in. diameter, and the other to grind drills from ½ in. to 3 in. in diameter. Drive is by means of a suitable motor with a two step pulley so as to obtain the necessary peripheral speed of the grinding wheels. On special request the machine can be easily arranged for countershaft drive.

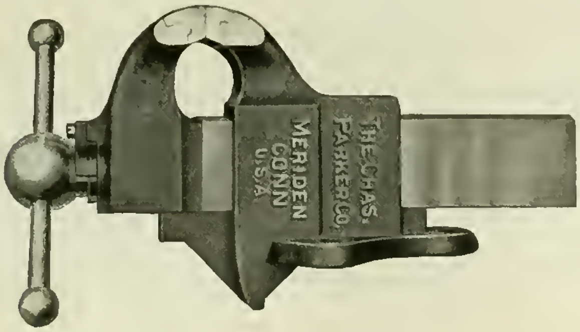
The great importance of a properly sharpened drill has long been realized and the drill manufacturers have always stood ready to afford the user of drills all possible information concerning the proper clearance and angle of the drill and correct methods of sharpening. As a matter of fact, a drill not properly sharpened will not only ruin the drill itself, but will cause all kinds of unnecessary expense such as breakage of machinery, wear of jigs and loss due to spoiled machine parts which must be sent to the scrap heap.



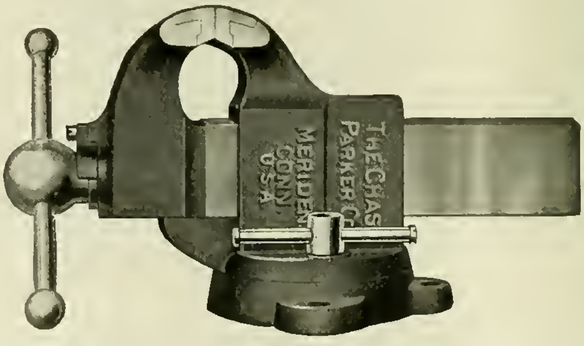
Twist Drill Grinder, Semi-Automatic in Action

Convenient and Durable Bench Vises

In the latest design of bench vises manufactured by the Charles Parker Company, Meriden, Conn., every effort has been made to produce a strongly made vise and one which will be convenient to use on account of the ability to swivel it at any required angle independent of previously determined, angular stop positions. The new vise in the 4-in. size has been made approximately 30 lb. heavier than earlier styles and solid (not cored) semi-steel castings are used to insure maximum rigidity and strength. A swivel clamping device which holds to the entire circumference of the side wall is provided. This arrangement is so designed that when the clamping screw is tightened, pressure is brought to bear on a V-shaped wedge which expands a ring against the base and holds the vise firmly. The under portion of the slide is made solid, as shown in the illustrations and strengthened by means of an inserted steel bar. The two steel jaw faces are separate, removable and



Parker Vise Furnished with Stationary Base

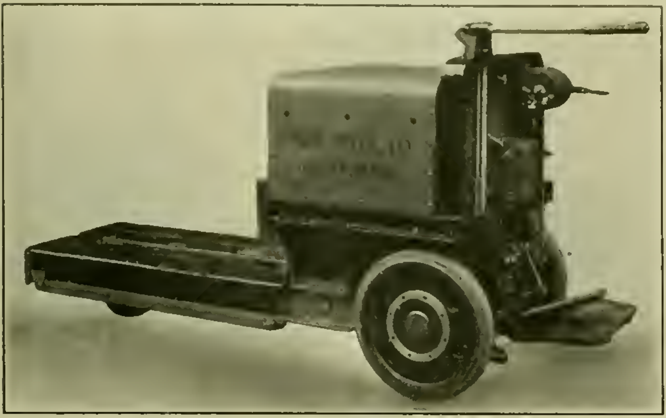


Improved Bench Vise with Swivel Base

renewable which is an important advantage. They are not welded or fastened to the jaw faces by screws which often work loose but are milled and fitted accurately, being held in place by pins. The vise is made in seven sizes with jaw openings from 3¼ in. to 7 in. as illustrated, and can be provided with a stationary base if that type of vise is desired.

Improved Electric Self-Loading Truck

SEVERAL distinctive features have been included in the recently improved truck, illustrated, which is made by the Cowan Truck Company, Holyoke, Mass. Simplicity of design is combined with a minimum of parts all sturdily constructed. The guaranteed capacity of the truck is 5,000 lb.



Cowan Electric Self-Loading Truck

The lifting mechanism is of the heavy bell crank type, a new application to electric truck lifting mechanism construction. It is actuated by an independent, heavy duty, series wound motor with a worm gear reduction, the platform elevating vertically with a maximum rise of 4½ in.

The truck, equipped with a full capacity battery, elevates a 5,000 lb. load in five seconds, and elevates without load in three seconds. The full lowering time is three seconds. The platform may be stopped at any point going up or down and the direction of motion reversed.

An "anti-kick" device takes all jar from the steering handle when the truck travels over rough spots. The power axle consists of only three parts, a shaft, splined ball and clutch. The rear end is equipped with a heavy bumper which effectually takes all shocks and protects the rear end of the lift platform. It is also equipped with a draw bar attachment, permitting the truck to be used as a light duty tractor. The draw bar attachment is integral with the frame and, with a load on platform, there is no strain on the elevating mechanism.

Other important features include an automatic brake and circuit breaker application, four wheel steer, single reduction worm drive of the power axle and easy accessibility of batteries, lifting and driving motors and control mechanism. The batteries are assembled in one tray for quick removal and are supported by springs which relieve them from road shocks and vibrations under all conditions of load. The controller is of the drum type with three speeds forward and three reverse.

The turning radius (extreme outside point) is 7 ft. 10 in. By folding the foot pedal and steering handle into a vertical position, the overall length is shortened for use on elevators. The length is 102 in. overall, or 91½ in. with the step raised. The width is 36 in. overall and 51 in. high over the steering shaft head. The truck will operate in intersecting aisles 58 in. wide. Further advantages of this truck are its all-steel construction, low center of gravity and ruggedness, features which are of particular value for the more or less severe usage accorded trucks in railroad service.

Sectional Wheel Chuck for Face Grinder

INSTEAD of a solid ring of abrasive material the Diamond Machine Company, Providence, R. I., has developed for use on the Diamond heavy duty face grinder a sectional wheel made up of twelve segments. Each segment is held in place by two wedges. Each alternate wedge is fastened; the other is movable. The grade and grain of abrasive used in the blocks or segments is the same as that used in the solid abrasive ring. The blocks are tightened in place by means of six square head set screws countersunk in the periphery of the chuck. The same means for setting out the blocks is employed as in the case of the solid wheel; namely, a cast steel backing plate is drawn forward by six set screws. The blocks can be furnished either 2 or 3 in. wide whichever may be desired.

The life of the segments has been found to be approximately the same as that of the ring wheels. No undue spawling or breaking down of the corners is observed. Furthermore, in the case of work having wide area, the use of the sectional wheel tends to diminish the area of contact. It is maintained that the openings between the segments permit freer cutting and cooler grinding, thus diminishing heating or warping of the work if the feed is crowded. The basis of this claim seems to be that the openings between the blocks permit of easy access of lubricant between wheel and work.

Comparison between the prices of segment and ring wheels shows that the cost of segment blocks is less than one-half the cost of solid ring wheels. Sectional chucks are now standard equipment for new machines and can be furnished for machines in service if the latter are not so equipped.

Diamond Sectional Grinding Wheel Chuck

Three-Quarter Inch Double Spindle Threader

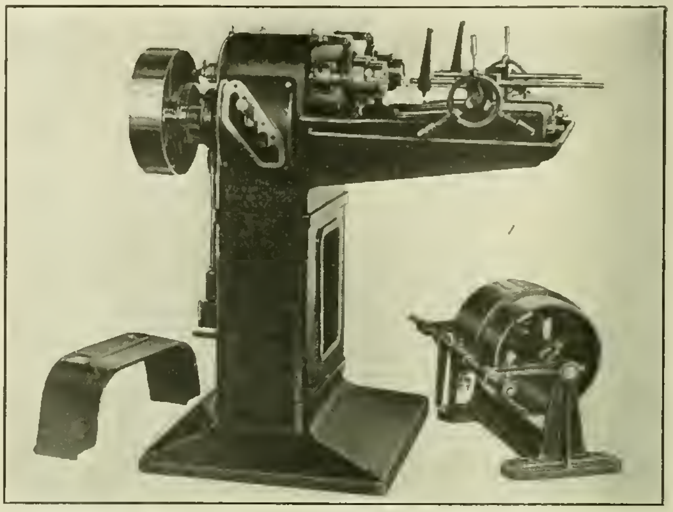
THE machine, illustrated, is designed primarily for threading work in which the threading time for both pieces is sufficient to allow the operator to chuck and start a second piece while the first is being completed. For this class of work the double spindle threader is a rapid producer, handling practically as much work as two single spindle machines with two operators. For tapping sizes smaller than is practicable with a collapsing tap, the use of the machine fitted with a ball drive reversing tap holder is recommended. The two spindles, mounted in large bronze bearings, are driven by a single pulley, located at the rear of the machine, but can be driven independently by means of the change gear levers at either side of the machine. Each carriage is fitted with a two-jaw chuck, operated by a hand wheel. An adjustable stop on the trip rod ahead of the carriage governs the opening of the die head and the length of the thread to be cut. The adjustable stop back of the carriage controls the closing of the die head.

A single geared pump, driven from the main shaft by means of bevel gears and a flexible shaft, forces oil from the reservoir through the spindles and die heads against the work. When equipped with a collapsing tap or reversing tap holder, the oil is fed through pipes on the outside of the machine. The lubricating system may be easily removed for cleaning and inspection.

Change gear levers on the sides of the machine control the spindle speed independently and may be set to furnish the proper speeds for the threads being cut.

A safe cutting speed for any diameter is one which will insure the maximum production without causing excessive wear on the chasers. If the speed for which the machine is designed is too fast to permit of this it should be run more slowly, regardless of the index. Accuracy depends to a very large extent on the cleanliness of the die head. The die head should be inspected periodically, all dirt, chips and gummed lubricant being removed. The use of a suitable lubricant makes a better thread, prevents wear and overheating and keeps the die head cleaner.

The ¾ in. double spindle threading machine is regularly equipped with ¾ in. geometric die heads, giving a cutting range of ¼ in., ⅜ in., ½ in., ⅝ in. and ¾ in. diameter and ⅛ in. to ½ in. standard pipe. The greatest length that can be cut at one setting of the work is 8½ in. With resettings a length of 14 in. may be cut.

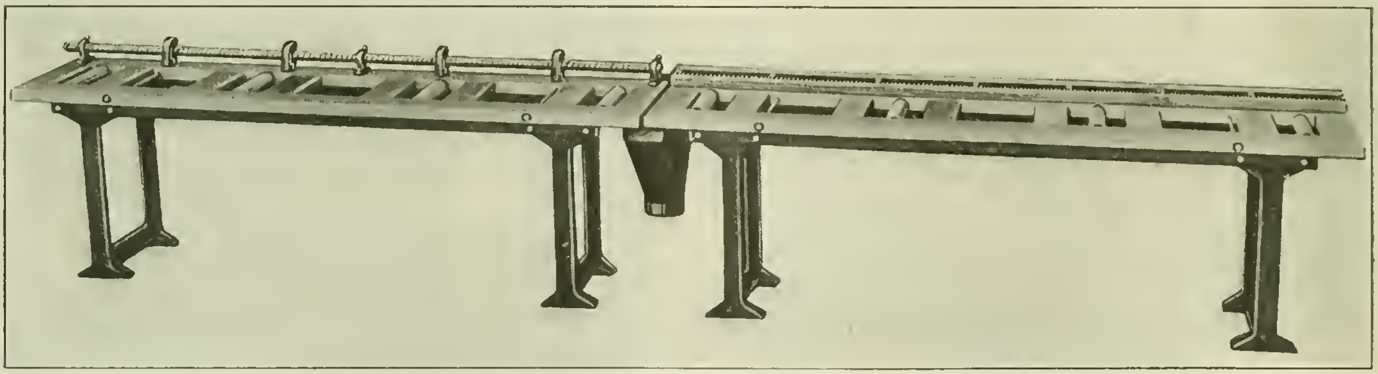


Geometric ¾-In., Double Spindle Threading Machine

When the countershaft speed is 373 r.p.m. the spindle speeds for cutting ¼ in., ⅜ in., ½ in., ⅝ in., ¾ in. are 225; 150; 113; 90 and 75 r.p.m., respectively. When the machine is fitted for motor drive, a 3-hp. motor is required.

Overhead Swing Cut-Off Saw Table

A SAW TABLE designed to be used with an overhead swing saw has been placed on the market recently by the Oliver Machinery Company, Grand Rapids, Mich. This table is 16 ft. long, 19½ in. wide and 30 in. high, being made of kiln dried, rock maple with angle iron girths and one piece cast iron legs. The table is composed of two parts of sections. On the rear of the right hand section is mounted the scale rail, graduated in ⅛ in. from zero to 96 in. These graduations are plainly marked and accurate. On the left hand section is mounted a patent automatic swing cut-off saw gage in the form of a square rod, also graduated in ⅛ in. from zero to 96 in. Four automatic malleable iron stops are provided; also one center and two end rod holders.

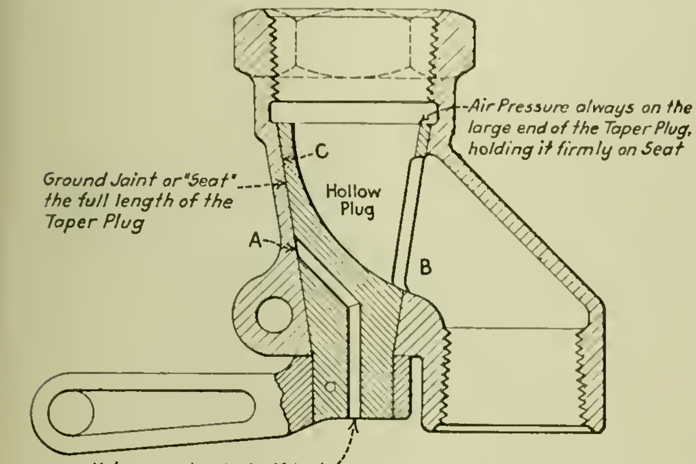


Special Oliver Table Designed for Use with an Overhead Swing Cut-Off Saw

Where a large number of parts have to be cut off to the same length this automatic saw gage is an important time saver. Rollers are inserted in both sections of the table in every other opening for the full length. A dust chute is fastened between the two sections of the table, having a 6-in. diameter pipe opening connecting to the exhaust system.

Pressure Seated Valve Reduces Air Losses

The Cleveland Pneumatic Tool Company, Cleveland, Ohio, has recently brought out an air valve for general use which contains new features of interest. The sectional drawing shows the new valve designed to eliminate air losses through leakage in transmission.



-Air Pressure always on the large end of the Taper Plug, holding it firmly on Seat

Ground Joint or "Seat" the full length of the Taper Plug

Valve may be shut off by turning Handle either way around. When shut, the Air Port "A" registers with Supply Chamber "B", allowing air trapped in hose to escape to atmosphere.

New Design of Pressure Seated Air Valve

The destructive action of compressed air upon valve seats, packing and gaskets is well known and this valve was designed so that air cannot come in contact with the seat, thus avoiding replacement of the seats. The design also utilizes air pressure as a seating agent to hold the valve plug on its seat, thus eliminating packing, gaskets, stems and springs and reducing the valve parts to a body, plug and handle.

A hollow taper plug in the supply chamber connects directly with the air hose without the air coming in contact at any time with the ground valve seat, which is the outer wall of the plug as indicated by the letter *C* on the drawing. The air travels through the wide unobstructed air passage of the valve which is free from any angle turns to impede its progress. A short arrow indicates the point on the large end of the plug where the air pressure is constantly forcing the taper plug against the walls of the valve body and forming a perfect seat.

The valve is provided with a unique waste arrangement to allow the accumulated pressure in the air hose to escape to atmosphere when the valve is shut off as shown by air ports *A* and *B* on the drawing. This arrangement safeguards the operator, who, when disconnecting the hose from the valve, often receives a gush of air in the face and accidentally gets scale or dirt in his eyes with more or less serious results.

The new valve has been subjected to severe service tests under both high and low air pressures (the high pressure being 500 lb.). Submerged water tests and exacting tests on acetylene gas lines have also been successfully passed.

Lathe Lead Screw Variator Device

For elongating or diminishing the normal lead of lathe lead screws, the Precision & Thread Grinder Mfg. Co., Philadelphia, Pa., has developed the device illustrated. This device facilitates the use of an ordinary lathe for precision lead work, correcting any errors in the lead. The variator is built in two models of similar design but different size. The model "A" is adjustable to fit lathes up to 12 in. swing, model "B" being adjustable to fit lathes with 13 in. to 20 in. swing.

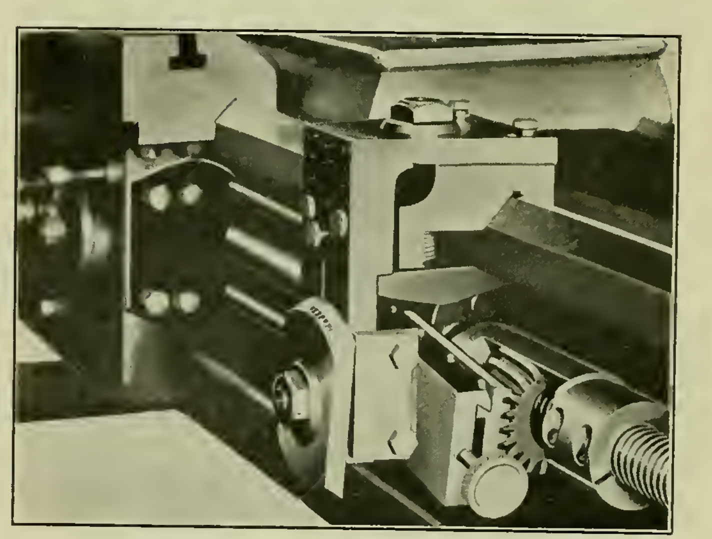
The device consists of a bracket, clamped upon the ways of the lathe and composed of two pieces, the outer frame, and the ways adaptor. The outer frame is adjustable horizontally, sufficient to make the proper connection between the bracket and the mechanism which is carried on the lead screw.

The bracket carries a swivel rack and provision is made for vertical adjustment to bring the rack swivel center in line with the center of the lead screw. This adjustment can be locked, and subsequent tilting of the rack does not disturb the vertical adjustment previously made. The rack is provided with a graduated scale to show the angular setting of the rack.

The lead screw mechanism consists of an adjustable nut with an extension carrying a gear segment free to swivel in line with the rack. The variation in the lead is obtained by this gear segment revolving in accordance with the swivel of the rack as the nut is traversed in either direction by the action of the lead screw. In using this variator, the regular lead screw nut in the lathe carriage is not employed, but connection is made between the variator nut and the lathe carriage by two rods and a plate. A longitudinal traverse of 6 in. is available.

Wear of the variator nut is reduced to a minimum because the nut moves the lathe carriage only during machining or grinding operations. The return of the carriage to the initial position is obtained by a sliding nut, keyed in the variator nut frame and permitting independent longitudinal movements in excess of the possible variation of lead. This is an important feature.

A dust guard is furnished to protect the lead screw from abrasive dust in grinding operations. It is recommended that the device be positioned near the threaded end of the lathe screw as that portion of the lead screw is generally unused, and more nearly correct than other sections.



Lead Screw Variator Applied to Lathe

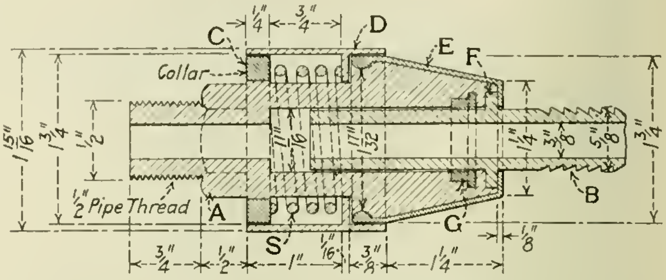
Air Hose Coupling of Simple Design

SIMPLICITY and rugged construction are features of a new air hose coupling invented by John Ph. Weber, 881 Park street, San Bernardino, Cal. Several of these couplings have been used for some time in the shops of the Atchison, Topeka & Santa Fe and have proved satisfactory in withstanding the severe usage accorded air hose couplings in railroad shops.

A particular advantage of the coupling is the fact that two hose parts can be connected together without twisting or turning of any kind. All that is required is to enter one part of the coupling into the other and push the two parts firmly together. They are then released by pulling back a knurled sleeve. On account of the gasket being inside, it is protected from injury and fits tight around the outside of the male part, forming an air tight joint.

Referring to the illustration, details of construction will be evident. Part *A* is made of cast iron, turned and bored as indicated, with a thread on one end to make into the air line. Part *B* is roughed on one end in order to be held more securely in the hose when the outside clamp is tightened. Collar *C* is a drive fit on part *A* and holds a knurled sleeve *D* in the position shown by means of spring *S*. Snap spring *E* is arranged to fit on over shoulder *F* of part *B* and has four prongs of the cross section shown. *G* is an L-shaped gasket fitting in a corresponding groove in part *A* and making an air tight joint between the two coupling parts *A* and *B*.

In operation the part *B* is entered in part *A* and as these parts are forced together, spring steel snap *E* slides up on the taper end of *A*, pushing back sleeve *D* and entering the groove shown. Sleeve *D* springs back over the top of the spring snap *E* locking the same in the groove shown so that it is impossible for the coupling to blow apart or become disconnected without first pushing the sleeve back again. Another good feature of this coupling is the fact that air hose cannot become twisted by screwing on the air motor or hammer. The coupling acts as a swivel joint.



Air Hose Coupling for Shop Use

Portable Safety Vacuum Torch

MANY difficulties due to oil leaks and consequent danger of fire are prevented by the operation of portable torches on the vacuum principle. With this fact in mind the Norton Mfg. Co., Boston, Mass., has developed a portable safety vacuum torch, illustrated. This can be used for many pre-heating and steel straightening jobs in railroad shops and roundhouses. There is no pressure on the oil at any time, the torch being operated by a vacuum created by the passage of compressed air through the burner head. The result is that there can be no spurting or spraying of oil in case of breaks in the oil pipes or hose and the danger attendant on using oil under pressure is eliminated. On account of this fact and because it has withstood rigid tests, the Norton torch has been approved by the Associated Factory Mutual Fire Insurance Companies.

Portable Safety Vacuum Torch Adaptable to Use in Railroad Shops

In addition to the safety feature, the torch is said to be highly efficient, powerful and easy to manipulate. It lights instantly, requires no pre-heating and does not sputter. Either fuel oil or kerosene may be burned.

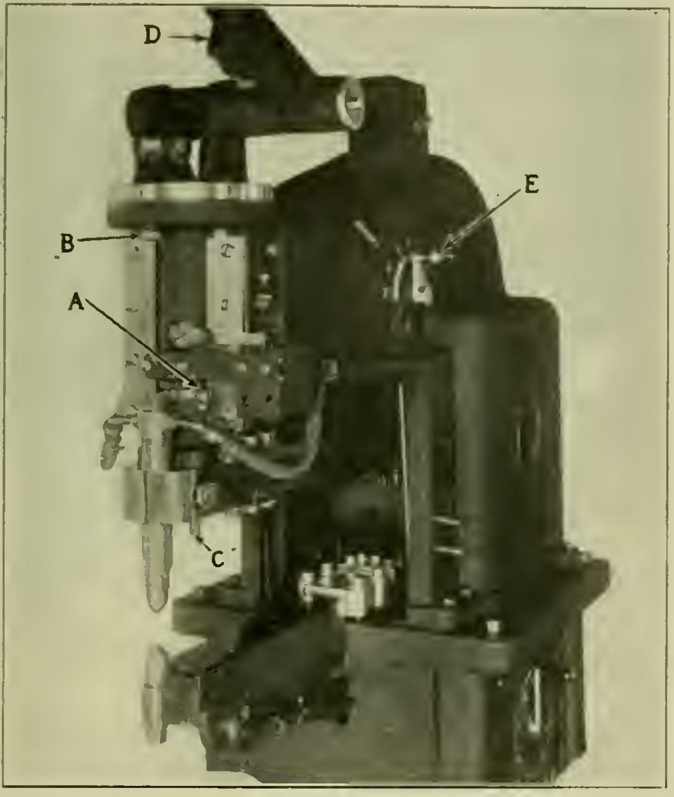
The tank is of heavy steel construction, being equipped with carrying candles and a rack welded on top for holding the torch when not in use. The torch is provided with two rubber tubes one conveying compressed air, and the other oil from the tank. The operating valve affords easy and accurate control of the flame. This portable safety vacuum torch was designed especially to withstand the severe requirements of railroad repair shops, boiler shops and foundries, and represents an important development for this purpose.

Dearborn Non-Volatile Liquid Cleaner

ONE of the disadvantages of liquid cleaners intended to dissolve oil, grease and dirt on machine parts has been the highly volatile, inflammable character of these cleaners and consequent danger of explosion of the gases given off. To overcome these dangers, the Dearborn Chemical Company, Chicago, has developed a compound known as Dearboline which not only has valuable solvent properties for removing foreign substances but does not give off highly explosive vapor and is said to be approved by the National Fire Underwriters Laboratories. Among the advantages claimed for Dearboline are solvent properties greater than gasoline, lower evaporation loss than kerosene, no danger of injuring the hands of workmen, reduction of fire hazards to buildings and contents, long maintenance of solvent properties thus making it cheap to use; and the fact that it does not have to be mixed but comes ready for use. Dearboline is furnished in steel drums of 55 gal. capacity and in small gallon cans if desired.

Spot Welding Machine of New Design

For welding heavy stock a new spot welder has been developed by the Taylor Welder Company, Warren, Ohio. The head on this machine has square slides and steel caps instead of round spindles, as formerly, so that any looseness due to wear may be readily taken up and the alinement of the electrodes maintained. The hand lever will swivel 90 deg. from each side of the center, and can be locked in any position by screw *B*. When operating by foot, the hand lever remains in the upper position. The height of hand lever can be changed to suit the operator by a segment on the side of lever *D*. The travel of the hand lever and the foot treadle can be regulated to seven different positions by means of lever *E* on the overhanging arm. The foot treadle swivels to right or left and can be removed when not in use without making any disconnections. Pressure on the work may be changed by adjusting screw *C* in the center of the upper electrode holder. Changing from automatic to a non-automatic switch is accomplished by moving the small lever *A*. Water circulates through the upper and lower welding electrodes, prolonging the life of the electrodes.



Taylor Series 4 Water Cooled Spot Welder

The Series 4 machine, illustrated, has a capacity to weld two pieces of sheet steel 1/64 in. to ¼ in. or 28 to 3 gage. A 25 kw. transformer operating at 220 or 440 volts, 25 to 60 cycle, single phase is generally used. There is a 10-step, self-contained regulator for adjusting the current. Automatic and non-automatic auxiliary switches operate a magnetic controlled switch on the rear of the machine.

The distance between the lower horn and the copper bands on slide horn machines with the horn at the top of the slide is 6 in. and with the horn at the bottom of the slide, 26 in. The distance from the floor to the welding electrodes is 42 in., the greatest movement of the upper electrode being 3 in. One set of 1¼ in. water cooled electrodes, consisting of two straight, two offset and one flat electrode are standard equipment.

The operation of this type machine is by hand lever and foot treadle, either together or independently. When using the automatic switch, the electrodes are brought in contact with the work under spring pressure. Further movement of the hand lever or foot treadle turns on the current and the work heats immediately to a welding temperature. Further movement of the lever or treadle turns off the current and applies a positive pressure to the molten metal, completing the weld. The non-automatic switch is operated by a button in the end of the hand lever, the electrodes being brought into contact with the work under positive pressure. This permits the operator to apply a heavy pressure before and after the current is turned on and off, additional pressure also being applied with the foot treadle. The machines can be furnished in single or double currents.

A New Idea in Chain Making

Electric welded chain is now being made in all the smaller sizes from stock up to ½ in. and ¾ in. round. There are a number of different methods of forming and welding the links, but in all cases a flash of material at the point of welding is brought about by jamming the two ends of material together at the intense heat of the electric arc. Some manufacturers do not try to remove this flash because of the extra strength that it gives the weld, while other manufacturers have invented means of either grinding or shearing the flash away, making the link smooth at the welded point.

A new method of electric welding just developed retains all of the material at the flash, or welding point, but forces it to the inside of the link. The illustration indicates clearly the form of the link that is thus secured. It is claimed that by this method the welded portion is 25 per cent stronger than any other part of the link, and repeated breaking tests show that the material will pull out at other places than the weld when tested to destruction. This kind of chain is very smooth on the outside of the links and the swelled portion on the inside gives it additional strength. The method of manufacturing chain by this special pattern has been patented and the name "Inswell" copyrighted by the manufacturers, the Columbus McKinnon Chain Company, Columbus, Ohio.

Electric Welded Chain, Made of Stock Up to ¾-In. Round

Metal Booth for Timekeepers and Foremen

One of the new developments of the Lyon Metallic Manufacturing Company, Aurora, Ill., is a time booth for the use of timekeepers, department foremen and others. The time booth is made up of standard enclosure panels 84 in. high by 36 in. wide. The standard booth includes six standard plain panels, one sliding door panel and one service window panel. This makes up a booth which is six feet square. Booths may also be made up in larger sizes by using more panels, thus making them 6 ft. by 9 ft., or 9 ft. by 9 ft., etc.

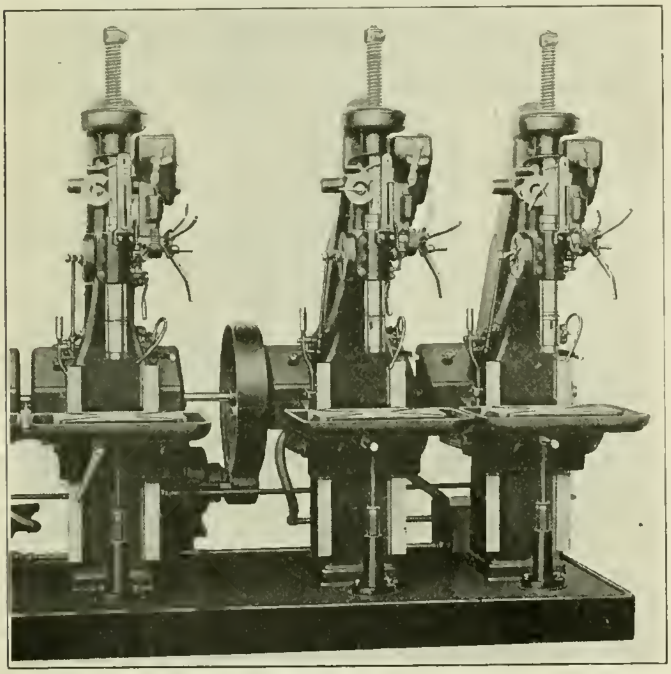
The booth is regularly equipped with a steel table, 30 in. wide, 60 in. long and 31 in. high. The table is made from heavy furniture steel, reinforced on the under side by a pan. This table can also be equipped with drawers and a compartment, if desired. The plain panels are made up of two upright members, a heavy sheet of steel closing the base of the panel to a point 43⅝ in. above the floor, and from this point upward the uprights enclose a No. 10 wire with a 1½ in. diamond mesh. The upright members are 1½ in. by ¾ in. by ⅛ in. channels, inside of which sets the 1 in. by ½ in. by ⅛ in. channel frame which covers the wire mesh on four sides. The panels are secured to the floor by a 1½ in. by 1½ in. by 8 in. angle.

The sliding door panel has a door 78 in. high. The hanger is equipped with grooved wheels which run on a track of 1¼ in. by 1¼ in. by 3/16 in. tee, bolted diagonally to a filler strip, making the door self closing. It is equipped with an S & G door lock, with a hand hole and latch inside. The service window lifts up, sliding in a channel slide leaving an opening 17½ in. high and 24 in. wide. A heavy shelf running the entire width of the panel and extending out 18 in. is attached horizontal with the bottom of the window and 43⅝ in. from the floor. The panels are bolted together through holes in the sides of the uprights. At the corners the upright members are bolted to a 2 in. by 2 in. by ⅛ in. angle, making a rigid unit.

Lyon Metal Booth Installed in Shop

Self-Oiling All Geared Gang Drill

A self-oiling, all geared drilling and tapping machine, made in 2, 3 and 4-spindle units has been developed by the Barnes Drill Company, Rockford, Ill. All bearings, aside from the spindle sleeves and cross spindles, are continuously oiled automatically, oil being forced by a geared pump in the reservoir of each machine to all gears and bearings, including the crown gears and feed box. Transmission gears, aside from the friction clutch gears and including the crown gear and pinion, are cut from a special high grade chrome nickel steel, heat treated and tempered to reduce wear and to increase strength and stiffness. This steel has a high tensile strength and the transmission gears are therefore able to resist severe stresses.



Barnes 22-In. Gang Drill Made in 2-, 3- and 4-Spindle Units

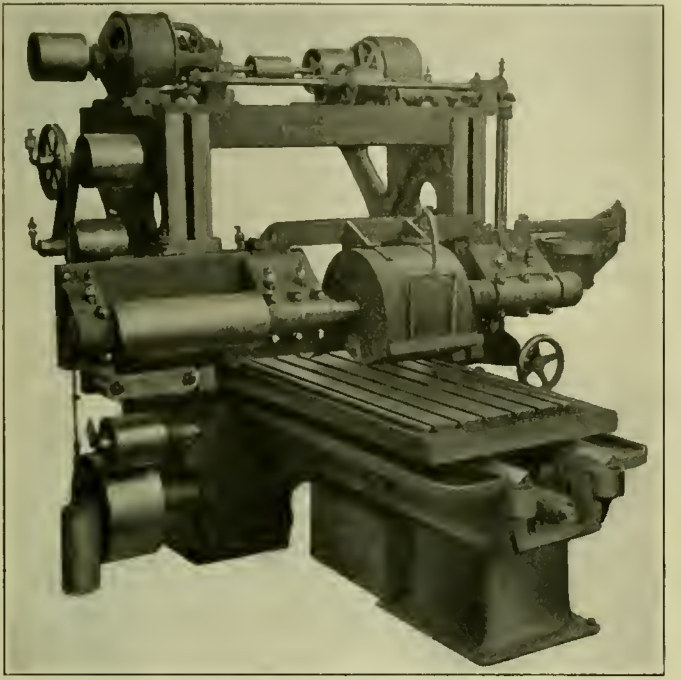
There are eight changes of speed for each spindle, all controlled by levers within easy reach of the operator from his position in front of the drill. Each spindle may be stopped by placing its shifter lever on neutral position or by throwing out the driving clutch. With one to one crown gearing, speeds from 58 to 575 r.p.m. are available. For tapping, two to one crown gears are used, giving eight speeds from 28 to 280 r.p.m.

Any or all spindles may be equipped with an automatic reversing mechanism, particularly desirable for depth tapping. The trip can be set so that the instant the tap reaches the depth required, the spindle will automatically reverse. Again, the shifting lever can be set so that when tripped automatically (or by hand) it will return to neutral position, thus stopping the spindle instantly instead of reversing it. The small hand trip lever, shown, is always ready for instant use if desired to reverse or stop the spindle at any point in the operation. If the automatic reverse is not required, drills can be furnished with a plain hand reverse lever instead.

The Barnes gang drill is designed to drive ½ in. to 2 in. high speed drills in solid steel. The height of the machine is 85½ in. The distance from the center of the spindle to the face of the column is 11 in. and from center to center of spindles (2- and 3-spindle machine) is 28 in. The center spindles of 4-spindle machines are 40 in. apart. The spindle travel is 14 in. The ratio of back gearing is four to one and the vertical travel of the table is 23 in. The speed of tight and loose pulleys is 500 r.p.m. Ten, 15 and 20-hp. motors are recommended for driving the 2, 3 and 4-spindle machines, respectively.

Oscillating Surface Grinding Machine

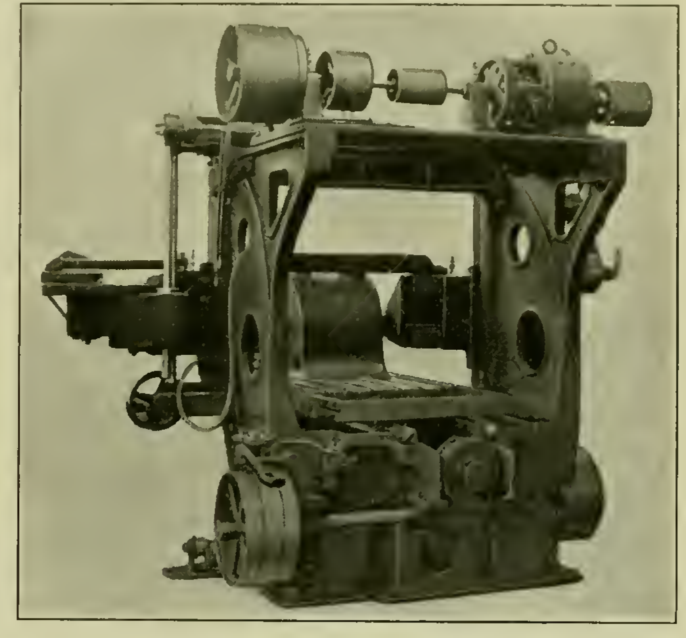
THE oscillating surface grinder, illustrated, has been arranged for motor drive and designed for heavy duty by the Springfield Manufacturing Company, Bridgeport, Conn. This machine is of heavy and substantial construction, carrying two wheels 20 in. in diameter and 6½ in. wide, on a spindle of 3½ in. in diameter. The spindle operates in bearings 3½ in. in diameter, by 18 in. in length.



Heavy Duty Oscillating Surface Grinder

One of the principal features of the machine is its direct motor application to an oscillating motion of the spindle, and this is accomplished by using a drum on the spindle and holding the belt stationary. The drum pulley is connected directly to the spindle and the whole mechanism is oscillated back and forth by means of a crank motion shown on the right hand end of the cross rail slides.

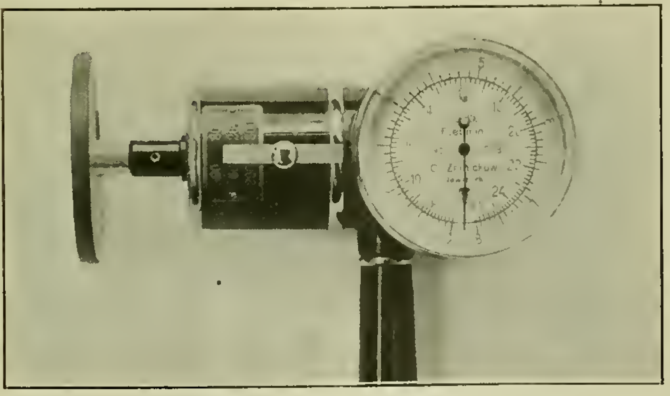
The machine shown has a capacity to grind 5 ft. long, 30 in. wide and 18 in. high, taking 52 in. between the uprights. The weight of the machine is 15,645 lb.



Rear View of Surface Grinder Showing Motor Drive Arrangement

Know Your Cutting Feeds and Speeds

IT should be a matter of pride with railroad shop foremen and machinists to know that they are getting from machine tools the maximum feeds and speeds, consistent with machine strength and the quality of work desired. The excuse that there was no ready and accurate means of determining cutting speeds and feeds no longer holds since the advent of a new device made by O. Zernickow, 15 Park Row, New York.



Speed and Feed Recording Device Aids in Increasing Production

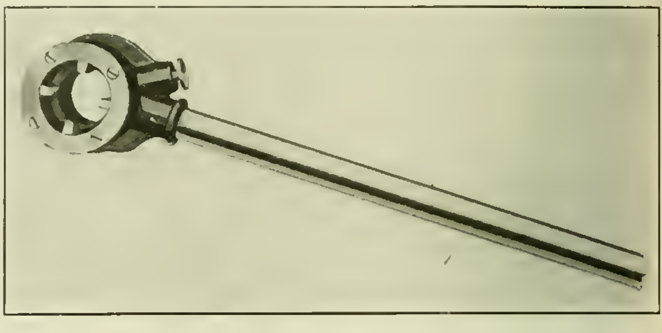
This device, known as the O-Z cutmeter, can be used in determining the cutting speeds of lathes, milling machines, planers, drills, etc.; also for ascertaining the speeds of pulleys, belts and ropes. Its operation depends upon the governor principle and the accuracy of the instrument is not affected by changes in temperature, moisture or magnetic fields. A damping mechanism minimizes the effect of vibration of the indicating hand and also neutralizes the shocks and vibration of the machine under test. This makes readings easy and distinct. Instantaneous readings in ft. per min. are shown and when used with a pointer, rev. per min. No watch is required in calculating the speeds.

The instrument is well balanced and will indicate with equal accuracy in vertical or horizontal positions. Three speed ranges are engaged by shifting a thumb slide shown in the illustration. For each range the full circumference of the dial is available, thus giving a wide space graduation.

Ratchet Die Stock in Close Quarters

The latest addition to the line of die stocks and pipe cutting tools made by the Borden Company, Warren, Ohio, is the Beaver No. 4 die stock, illustrated, which has been built especially for air line repairing. Air line threading is often difficult work because the pipes are inaccessible and it is impossible to swing a two-handled die stock. This difficulty has been overcome by applying a ratchet handle with a separate die head, as shown, for threading 1¼ in. air line pipe. The die stock is lightweight, sturdy and fool-proof tool, being simply constructed and well balanced. A convenient pawl with a strong spring operates the ratchet in threading and backing off. When desired a 1½ in. outside diameter 12-thread die head for superheater work can be furnished.

Obstructions, such as car bumpers, in no way interfere with the easy operation of the ratchet die stock and it should find ready use in all car repair shops and on cripple tracks where train line pipes have to be threaded in difficult places. It should prove an important aid in increasing the standard of train line maintenance on account of the ease in making necessary repairs. Under present conditions, if a slight leak develops due to a defective thread, where an angle cock makes on to the train line, a new thread cannot be cut without removing clamps, unscrewing the angle cock, disconnecting a pipe coupling somewhere under the car and removing a section of pipe to the shop to be rethreaded. The result of this condition is to put a premium on careless inspection since it is the inevitable tendency to neglect to report small leaks which are difficult to repair. The ratchet die stock will enable these repairs to be made easily and thus assist in keeping train lines tight.

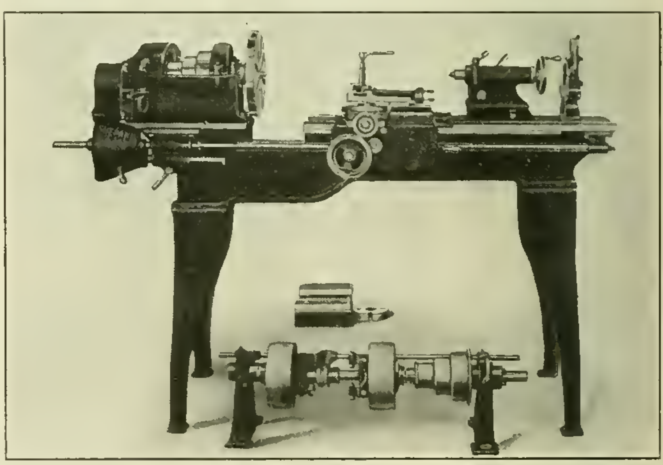


Beaver No. 4 Ratchet Die Stock

Cone Pulley Gap Bed Lathe

An addition to the line of engine lathes manufactured by the Shepard Lathe Company, Rising Sun, Ind., is the 12 in. gap bed lathe, illustrated. This machine is of particular interest to railroad machine shop men because widely varying diameters have to be turned in railroad shop work and it is a great convenience to be able to do this work on one machine. On account of the gap feature the lathe, illustrated, can swing 19 in. for lengths 5 in. in front of the face plate and thus the range of work which can be handled is greatly increased. In addition, the gap feature makes it possible to turn such work as air compressor piston rods on a relatively light high speed machine without removing the pistons and with a considerable saving in power.

The bed of the lathe is thoroughly reinforced, being designed for greater strength at the gap than at any other point in the bed length. The carriage is so arranged as to overrun the gap without letting down. Power longitudinal and cross feed is provided, and for turning long work, the steady rest shown on the end of the bed can be used. This particular gap bed lathe is driven through a counter shaft and 3-step cone pulley, but electric motor, geared head drive can be furnished if desired.



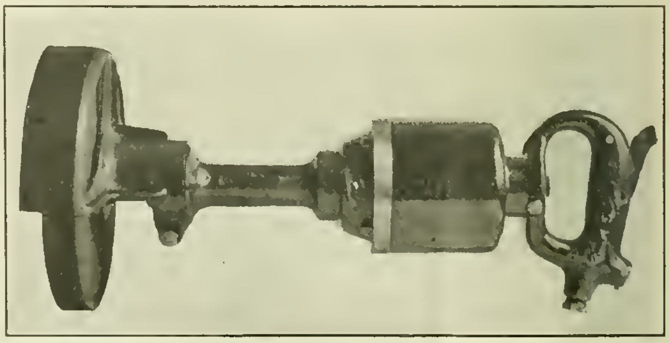
Shepard 12-Inch Gap Bed Lathe

Rotary Piston Pneumatic Grinder

A portable pneumatic grinder, recently designed and built by the Keller Pneumatic Tool Company, Chicago, is a radical departure from common practice in making portable grinders.

The motor is a rotary piston type, developing a high speed for grinding, with ample power to maintain the speed under load. No crank shaft or toggles are employed and the piston and connecting rod thrust are in a straight line at all times, eliminating toggle trouble, vibration and wear.

The new Keller grinders are built in two sizes, the smaller weighing but 5¾ lb. and the larger 18 lb. As will be noted in the illustration, the tool is well proportioned and balanced, being easily controlled by means of the grip trigger. The absence of vibration insures endurance in operator and tool.



Keller Rotary Piston Pneumatic Grinder Combines Power and Speed

Railway Mechanical Engineer

(Formerly the RAILWAY AGE GAZETTE, MECHANICAL EDITION
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WE GUARANTEE, that of this issue 9,300 copies were printed; that of these 9,300 copies, 8,010 were mailed to regular paid subscribers; 8 were provided for counter and news company sales; 261 were mailed to advertisers; 32 were mailed to employees and correspondents, and 989 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 58,700, an average of 9,783 copies a week.

The *Railway Mechanical Engineer* is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.)

The Illinois Central recently organized a committee of officers and employees to act as a General Fuel Conservation Committee. J. F. Porterfield, general superintendent of transportation, has been appointed chairman of the committee.

The Great Northern has abolished its Havre division. The lines of this division from Havre, Mont., to Cut Bank have been added to the jurisdiction of the Montana division, and the lines from Pacific Junction to Gibson, Great Falls to Shelby and Virden to Sweet Grass, Mont., have been added to that of the Butte division.

The hearing before an examiner of the Interstate Commerce Commission regarding the expenditures of the Pennsylvania Railroad for locomotive repairs made by the Baldwin Locomotive Works was resumed at Washington on May 9. J. T. Wallis, chief of motive power, was the principal witness. Announcement has been made that oral arguments on this case will be held at Washington on June 20.

The Missouri Pacific has abolished its Valley division, and has assigned the Pine Bluff district from Little Rock, Ark., to McGehee, to the Arkansas division, the McGehee district, from McGehee to Monroe, La., and the Hamburg district to the Louisiana division, and the Lake Providence district, the Eudora district and the Arkansas City and Warren branches to the Memphis division.

Tabular summaries of accidents occurring in the transportation of explosives and other dangerous articles during the first quarter of 1921 are shown in accident bulletin No. 51 of the Bureau of Explosives. The most serious catastrophe during this period was the casinghead gasolene explosion at Memphis, Tenn., on January 24 which caused thirteen deaths and a property loss of about $150,000. The bulletin also includes suggestions on reporting violations of the regulations, accidents, damages, etc., and describes several accidents, notably a fire caused by loading pyroxylin plastic articles against steam pipes in an express car.

Bird M. Robinson, president of the American Short Line Association, says that about 75 per cent of the employees of the short lines of the country have accepted reductions in wages. The amount of the reductions is not known with precision, but Mr. Robinson thinks the percentages were as great, and perhaps in some cases greater than, the reductions proposed by the larger railroads. It is said that nineteen disputes now before the Railroad Labor Board involve "short lines," and Mr. Robinson plans to go before the Board and show that that body has no jurisdiction of roads which were not operated by the government during the war.

Locomotive Orders

The American Locomotive Company has been given an order for 42 locomotives of the Pacific, Mikado and Mallet types for the Pekin-Kalgan Railway, China. Of the 42 engines there will probably be seven to ten Mallet type locomotives. Each locomotive and tender will weigh 640,000 lb. in working order.

American Specifications for France

The United States Department of Commerce is now translating into French, for publication in a French-English edition, 62 specifications of the American Society for Testing Materials particularly applicable to export trade. These specifications include those for rails and splice bars, structural and reinforcing steels, steel forgings and castings, steel wheels and tires, steel and iron tubes and pipe, boiler steels, wrought-iron products, pig iron, cast-iron pipe, malleable and gray-iron castings, copper wire, copper bars, spelter, bronze, cement, linseed oil and turpentine. These same specifications were translated into Spanish two years ago, and have since been distributed among consular offices and elsewhere in South America.

New Rules for Classification of Employees

New rules governing the classification of employees for statistical and reporting purposes, to go into effect on July 1, have been issued by the Interstate Commerce Commission. They provide for more detailed reports than have hitherto been required. The resulting statistics are intended to meet the needs of both the Railroad Labor Board and the Interstate Commerce Commission. The classification is made largely in accordance with the recommendations of the director-general of railroads. It is requested that duplicate copies of the reports be sent to the Labor Board. There will be 148 classes of employees, in place of the 68 classes heretofore used by the commission. The number of employees is to be counted 12 times a year as of the fifteenth of the month, with additional counts for certain occupations.

Rock Island Consolidates Divisions

The Chicago, Rock Island & Pacific has consolidated divisions, as follows: That part of the Minnesota division between Cedar Rapids and St. Paul-Minneapolis, and between Vinton, Iowa Falls, has been consolidated with the Cedar Rapids division, the consolidated division to be known as the Cedar Rapids-Minnesota division. That part of the Minnesota division between Vinton, Iowa, and Iowa Falls, has been consolidated with the Cedar Rapids division, the consolidated division to be known as the Cedar Rapids-Minnesota division. That part of the Minnesota division between Manly, Iowa, and Short Line Junction has been consolidated with the Dest Moines Valley division. The Colorado division has been consolidated with the Nebraska division, and is to be known as the Nebraska-Colorado division. The St. Louis division has been consolidated with the Kansas City terminal division, and is to be known as the St. Louis-Kansas City division. The Louisiana divison has been consolidated with the Arkansas division, and is to be known as the Arkansas-Louisiana division. The Indian Territory division has been consolidated with the Panhandle division, and is to be known as the Panhandle-Indian Territory division. The Amarillo division has been consolidated with the El Paso-Mexico division, the new division to be called the El Paso-Amarillo division.

Program for Annual Meeting of Mechanical Division A. R. A.

The Mechanical Division of the American Railway Association has issued a program for the business meeting to be held at the Drake Hotel, Chicago, June 15 and 16. The sessions will convene at 10:00 a. m. city time, which is 9:00 a. m. central standard time, and continue all of each day with luncheon period 12:30 to 2:00 p. m.

Reports from the following committees will be considered:

WEDNESDAY, JUNE 15.

General Committee.
Committee on Nominations.
Arbitration Committee.
Committee on Prices for Labor and Material.
Committee on Loading Rules.
Committee on Standard Method of Packing Journal Boxes.

THURSDAY, JUNE 16.

Committee on Car Construction.
Committee on Brake Shoe and Brake Beam Equipment.
Committee on Train Brake and Signal Equipment.
Committee on Tank Cars.
Committee on Specifications and Tests for Materials.

Election of officers will be held Wednesday, immediately after report of Nominating Committee is presented.

Advance copies of the reports to be considered will be mailed to the members before the meeting.

Locomotive Boiler Code Adopted by A. S. M. E.

An important step in engineering standardization was taken at the Boston meeting of the council of the American Society of Mechanical Engineers, when it adopted in its final form that portion of the A. S. M. E. Boiler Code known as the Locomotive Boiler Code. This code contains the rules for the construction of locomotive boilers which are not subject to federal inspection and control.

The necessity for such an addition to the Boiler Code arose from the fact that, while the boilers of locomotives operated on railways engaged in interstate service are covered by the construction and inspection rules of the Interstate Commerce Commission, there was found to be a vast mileage of industrial and short-line railroads in operation in the various states, which by virtue of their location, are not subject to the interstate requirements.

As a result of calls for a code to cover the construction of boilers of this class, the Sub-committee on Railway Locomotive Boilers was appointed in 1916. This committee consisted of F. H. Clark, chairman; F. J. Cole, chief construction engineer of the American Locomotive Company; A. L. Humphrey, vice-president and general manager of the Westinghouse Air Brake Company; S. F. Jeter, chief engineer of the Hartford Steam Boiler Inspection & Insurance Company; William F. Kiesel, Jr., mechanical engineer of the Pennsylvania, and H. H. Vaughan, vice-president of the Dominion Copper Products Company, Montreal. The work of this sub-committee was interrupted somewhat by the war, but its preliminary report was submitted to the Boiler Code Committee in April, 1919.

The preliminary report was printed and distributed at the Spring Meeting in Detroit where it was accepted by the meeting. It was thereupon published in the August issue of *Mechanical Engineering.* The sub-committee has been co-ordinating the points of view of all who would be affected by such a code and the final result approved by the main committee and the council is now ready for use. H. V. Wille, assistant to the vice-president of the Baldwin Locomotive Works, and Kenneth Rushton, chief mechanical engineer of the Baldwin Locomotive Works, were brought into the committee and with Mr. Cole and James Partington, estimating engineer of the American Locomotive Company, appointed in place of Mr. Humphrey, resigned, represented the locomotive manufacturers.

Constructive assistance was given by the Mechanical Division of the American Railway Association through its representatives, A. W. Gibbs, mechanical engineer of the Pennsylvania; W. I. Cantley, of the Lehigh Valley; and N. A. Ferrier, of the New York Central. A. G. Pack, chief inspector of the Bureau of Locomotive Inspection, Interstate Commerce Commission, has expressed great interest in the code and with his staff has been in frequent attendance at meetings of the sub-committee.

During the past two years Mr. Clark, the original chairman of the committee, has been in China as Technical Adviser to the Ministry of Communications at Pekin. Mr. Vaughan has carried on the work of the committee as acting chairman.

The code, itself, follows the general form of the Code for Stationary Boilers. The materials to be used and methods of construction of the various braced and stayed surfaces are very carefully specified. Attention is given to the desire of the locomotive builders to maintain the lowest possible weight consistent with strength. As compared with stationary boilers with a safety factor of five the allowable factor for locomotive shells is four. Requirements in the use of safety valves and their method of test are rigid as are the hydrostatic tests specified.

MEETINGS AND CONVENTIONS

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Business meeting June 15 and 16, Hotel Drake, Chicago, Ill.

Division V—Equipment Painting Division.—V. R. Hawthorne, Chicago.

American Railway Association, Division VI—Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio. Convention June 9, 10 and 11, Hotel Blackstone, Chicago, Ill.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamlin Ave., Chicago. Convention September 12-14, Hotel Sherman, Chicago, Ill.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago. Convention August 9, 10 and 11, Hotel Sherman, Chicago, Ill.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting June 20 to 24, inclusive, New Monterey Hotel, Asbury Park, N. J.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention September 19-24, Indianapolis, Ind.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Mootreal, Que. Meeting second Tuesday of each month except June, July and August, at Windsor Hotel, Montreal.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Meeting second Monday in month, except June, July and August, New Morrison Hotel, Chicago, Ill.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 95 Liberty St., New York, N. Y.

Chief Interchange Car Inspectors and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Meeting second Tuesday of February, May, September and November, at Hotel Sinton, Cincinnati.

Dixie Air Brake Club.—E. F. O'Connor, 10 West Grace St., Richmond, Va.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 715 Clarke Ave., Detroit, Mich. Next meeting August 16, 17 and 18, 1921, Hotel Sherman, Chicago, Ill.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn. Convention, September 12, 13, 14 and 15, 1921, Hotel Sherman, Chicago, Ill.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York, N. Y.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Meeting second Tuesday of each month, except June, July, August and September.

New York Railroad Club.—H. D. Vought, 95 Liberty St., New York, N. Y.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Meeting second Friday of each month, except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Meeting third Monday of each month, except June, July and August.

PERSONAL MENTION

GENERAL

W. P. Kershner, who has been appointed superintendent of motive power of the International & Great Northern, with headquarters at Palestine, Tex., was born at West Leesport, Pa., August 16, 1885. He graduated from high school at Reading, Pa., in 1901, and began his railroad career as a night caller, for the Philadelphia & Reading. Shortly thereafter he became a machinist apprentice and later a machinist for the Reading, and resigned to attend the University of Pennsylvania, from which he graduated in 1908. He then entered the employ of the Louisville & Nashville at South Louisville, Ky., as a layer-out on new engines. Later he served the Chicago & North Western in the office of the mechanical engineer. He left that position to go with the Northern Pacific at Livingston, Mont., and shortly afterward resigned to enter the service of the Chicago, Milwaukee & St. Paul at Lombard, Mont. Later he became general foreman for the Oregon Short Line, at Montello, Idaho. He next became a hydraulic engineer for the Bishop Creek Mining Company at Laws, Cal., but soon afterward entered railroad service again—this time as a drop-pit foreman for the Southern Pacific. Subsequently he was in the employ of the Texas & Pacific, the International & Great Northern and the Missouri, Kansas & Texas. During the war Mr. Kershner served as second lieutenant, captain and major in the engineers and saw 17 months' service overseas. After his discharge from the service he went to the Texas & Pacific as general mechanical inspector and was later promoted to shop superintendent. A few months later he left this position to become master mechanic of the International & Great Northern at Palestine, Tex., which position he held at the time of his recent appointment.

Frank S. Robbins, formerly master mechanic of the Pennsylvania at Pittsburgh, has been appointed mechanical advisor to the Chinese Eastern Railway, which is a part of the Trans-Siberian System. He will serve under the direction of J. F. Stevens, president of the Inter-Allied Technical Board of the Orient. Mr. Robbins was born at Menantico, N. J., December 22, 1880, and was educated at Purdue University. Upon graduation in mechanical engineering he entered railroad work as a machinist apprentice with the Union Railroad in New Jersey. He later entered the Altoona shops of the Pennsylvania Railroad as special apprentice and upon completion of this course was appointed motive power inspector at the West Erie shops. In 1909 he was appointed assistant master mechanic of the Monongahela division, and, in 1911, assistant road foreman of engines, Renova, Pa. In 1912 he was appointed assistant general foreman of the car shops at Pitcairn, Pa., and in 1913 was promoted to master mechanic of the Pittsburgh division.

In 1917, Mr. Robbins entered military service and was commissioned a captain in the Railway Engineers, being assigned to command Company D of the 19th Engineers (Railway). While a member of the American Expeditionary Forces in France his railroad experience was of considerable assistance in constructing railway shops at Bassens and organizing the personnel for their operation. He was appointed superintendent of motive power of "D" line and as a result of his work was promoted to the rank of major of engineers. In 1919, Major Robbins was discharged from military service and was appointed assistant engineer, maintenance of equipment, in the office of the assistant to the president of the Pennsylvania at Philadelphia. In December, 1919, he was appointed master mechanic of the Pittsburgh division, which position he held until the reorganization of the Pennsylvania. Upon the return of the roads to their owners, Mr. Robbins was appointed master mechanic of the new Pittsburgh Terminal division. On March 15, 1921, he resigned his position with the railroad company to serve with the Inter-Allied Technical Board. Mr. Robbins' headquarters in his new position will be at Harbin, Manchuria.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

E. C. Huffman, superintendent of the Great Northern, with headquarters at Breckenridge, Minn., has been appointed master mechanic of the Sioux City division, with headquarters at Sioux City, Ia., succeeding F. J. Fero, deceased.

T. E. Paradise, assistant superintendent of motive power of the Chicago, Burlington & Quincy, with headquarters at Lincoln, Neb., has been appointed master mechanic, with headquarters at Hannibal, Mo., succeeding H. Modaff, who has been transferred to Ottumwa, Ia. Mr. Paradise was born on November 22, 1880, at Peoria, Ill., and entered the employ of the Chicago, Burlington & Quincy as a machinist apprentice in October, 1899. In April, 1902, he enlisted as a machinist in the navy, and in January, 1907, returned to the Chicago, Burlington & Quincy. From 1913 to August, 1916, he was roundhouse foreman at Grand Crossing, Wis.; from August, 1916, to April, 1917, master mechanic at Centerville, Ia.; from April, 1917, to September, 1918, master mechanic at Hannibal; from September, 1918, to March, 1920, mechanical assistant to regional director, Central Western Region; and from March, 1920, to May 1, 1921, assistant superintendent of motive power, Lines West. The position of assistant superintendent of motive power at Lincoln has been abolished.

J. F. Speigle has been appointed assistant master mechanic of the Canadian National, with headquarters at Hornepayne, Ont., succeeding W. G. Strachan, who has been transferred to Capreol, Ont.

H. D. Turner, master mechanic of the Chicago, Burlington & Quincy at Ottumwa, Ia., has been appointed road foreman of engines, with headquarters at Burlington, Ia.

CAR DEPARTMENT

David M. Rankin has been appointed car foreman of the Chicago, Rock Island & Pacific at Dalhart, Tex., succeeding Robert L. Ridling.

SHOP AND ENGINEHOUSE

Paul J. Schenck has been appointed general foreman of the Chicago, Rock Island & Pacific shops at Dalhart, Tex., succeeding James McLeod.

C. E. Shoup has been appointed general foreman of the New York Central at Englewood, Ill.

Lee Stanford has been appointed roundhouse foreman of the Santa Fe at Gallup, N. M.

Clarence White has been appointed general foreman of the Santa Fe at Newton, Kan.

J. A. Woods has been appointed foreman of the Atchison, Topeka & Santa Fe at Bagdad, Cal., succeeding C. J. McCue. Mr. McCue has been made general roundhouse foreman at Needles, Cal.

PURCHASING AND STOREKEEPING

W. H. King, Jr., whose appointment as general purchasing agent of the Seaboard Air Line was announced in the May issue of the *Railway Mechanical Engineer*, was born on April 20, 1883, at Portsmouth, Va. His education was continued through high school and preparatory school. In 1900 he entered railway service with the Seaboard Air Line as a clerk in the accounting department. Two years later he became a clerk in one of the company's agencies, and the following year became a clerk and statistician in the accounting department. In 1910 he was appointed assistant statistician in the operating department, and, in 1912, chief statistician and fuel agent. He was promoted to chief statistician in 1913 and four years later became the assistant to the president and federal manager, and also general manager of subsidiary lines. He was appointed assistant to the vice-president, and vice-president of the Baltimore Steam Packet Company in 1920, which position he held at the time of his recent appointment.

J. E. Mahaney, general storekeeper of the Seaboard Air Line, has been appointed superintendent of stores of the Chesapeake & Ohio, with headquarters at Huntington, W. Va.

R. M. Nelson, purchasing agent of the Chesapeake & Ohio, has been appointed assistant to the director of purchases and stores, with headquarters at Richmond, Va. The position of purchasing agent has been abolished.

W. J. Sidey, general storekeeper of the Buffalo, Rochester & Pittsburgh, has been assigned other duties and the position of general storekeeper has been abolished. Officers and employees heretofore reporting to the general storekeeper will report to the chief engineer.

H. C. Pearce

H. C. Pearce, general purchasing agent of the Seaboard Air Line, has resigned to become director of purchases and stores of the Chesapeake & Ohio and the Hocking Valley, with headquarters at Richmond, Va. Mr. Pearce was born on June 1, 1867, at Westberry, Quebec, and was graduated from St. Charles - Baromme College at Sherbrooke, Quebec. He entered railway service in 1885 as a clerk in the office of superintendent of the Minneapolis, Lyndale & Minnetonka and subsequently served as a material clerk and conductor on the same line. In 1887 he went with the Minneapolis, St. Paul & Sault Ste. Marie as a clerk to the superintendent of construction. He later served as a clerk in the auditor's office, chief clerk to general super- clerk to general superintendent, general storekeeper and purchasing agent. He went with the Chicago, Rock Island & Pacific in April, 1903, as assistant purchasing agent. The following year he was appointed general storekeeper and remained in that position until 1906, when he resigned to enter the service of the Southern Pacific in a similar capacity. In 1913 he became general purchasing agent of the Seaboard Air Line and remained in that position until his present appointment. Mr. Pearce is chairman of the division of purchases and stores of the American Railway Association.

OBITUARY

H. Boutet

Henry Boutet, chief interchange car inspector at Cincinnati, Ohio, died at his home in Ludlow, Ky., on April 25. Mr. Boutet was born in Cincinnati on November 18, 1851. He served his apprenticeship with the Mowry Car Works and then entered the car department of the Pennsylvania railroad, with which road he remained for five years. He then entered the service of the Cincinnati Southern as a car builder and was later promoted to foreman of the car department at Ludlow where he remained nine years, when he was appointed chief interchange car inspector, which position he held until his retirement September 1, 1920, on account of failing health. Mr. Boutet was a member of the Master Car Builders' Association and Chief Interchange Car Inspectors' and Car Foremen's Association. He was president of the Chief Interchange Car Inspectors' Association from 1905 to 1911 inclusive. This association was formed at a meeting of chief interchange inspectors which was called by Mr. Boutet in March, 1898, at Cincinnati. He was also secretary of the Cincinnati Railway Club from its organization in July, 1912, until the time of his retirement in 1920.

SUPPLY TRADE NOTES

The Industrial Car Manufacturers' Institute has removed its executive office from Pittsburgh, Pa., to 68 William street, New York City.

The Ralston Steel Car Company has moved its Chicago offices from 20 East Jackson boulevard to the Fisher building, 343 South Dearborn street.

Homer C. Johnstone, formerly with the Midvale Steel Company, now represents the Gould Coupler Company, with headquarters at New York City.

The Galena-Signal Oil Company will remove its New York City office on June 1, from 17 Battery Place to the Liggett building, 41 East Forty-second street.

Raymond R. Bilter, formerly secretary of the Trumbull Waste Manufacturing Company, Philadelphia, Pa., is now associated with the Railway Supply & Manufacturing Company, Cincinnati, Ohio.

V. Z. Caracristi

V. Z. Caracristi, until recently a member of the Railway & Industrial Engineers, Inc., has opened consulting offices at 43 Broad street, New York. Mr. Caracristi has been identified with the railway and industrial fields for the last twenty-two years. He was at one time shop engineer and maintenance supervisor of the Richmond plant of the American Locomotive Company, and later general maintenance supervisor of all the plants of that company. He was associated as designer and constructor of the Union Station, Washington, D. C., and was assistant to the general superintendent of motive power of the Baltimore & Ohio. He was later in the employ of the Wheeling & Lake Erie, where he carried out improvements in the Brewster shops, and shortly after did similar work in the Watervliet shops and Carbondale terminal of the Delaware & Hudson. He also supervised the layout, design and equipment of extensions to the plant of the Lima Locomotive Works, Inc. From 1913 to 1919, Mr. Caracristi was engaged in consulting work for banking interests and during this period devoted considerable effort to development work on the burning of pulverized fuel in suspension. In 1919, with J. E. Muhefeld, he formed the Railway & Industrial Engineers, Inc. Mr. Caracristi will specialize in consulting work in railroad and shop design, operation and betterment.

The H. K. Ferguson Company, Cleveland, Ohio, has removed its Chicago office from the Rookery building to 1637 Monadnock Block. O. C. F. Randolph remains in charge of the Chicago territory.

W. F. Robinson, for many years connected with James B. Sipe & Co., Pittsburgh, Pa., has been appointed manager of the railroad sales department of the Tropical Paint & Oil Company, Cleveland, Ohio.

The Ross Heater & Manufacturing Company, Inc., Buffalo, N. Y., has opened a branch office at 2 Rector street, New York City, and has discontinued its sales agency. The new office is in charge of C. M. Hardin, who was formerly located at the home office.

Clement F. Street, formerly vice-president of the Locomotive Stoker Company, has opened an office in the Smith building, Greenwich, Conn., for the purpose of placing on the market the Street locomotive starter for application to locomotive trailer trucks and tenders.

The Automatic Coupler & Trailer Equipment Company, 954 West Twenty-first street, Chicago, has been incorporated with a capital of $100,000, by Norman T. Brenner, Meyer B. Mervis and Charles A. Holland, to manufacture railroad and other heavy mechanical equipment.

Ralph S. Cooper, vice-president and general sales manager of the Independent Pneumatic Tool Company, 600 West Jackson boulevard, Chicago, has been appointed general manager in addition to his other duties. Mr. Cooper has just returned from Europe, where he has established branch offices and agencies for the company.

J. M. Davis, formerly vice-president of the Baltimore & Ohio, has been elected president of Manning, Maxwell & Moore, Inc., 119 West Fortieth street, New York City, to succeed the late A. J. Babcock. Mr. Davis was born on November 5, 1871, and began railway work in 1888, as a freight brakeman on the San Antonio & Aransas Pass. From September, 1891, to 1900, he served consecutively as stenographer to the superintendent of the Gulf, Colorado & Santa Fe, chief clerk to the superintendent of the Mexican Central, clerk in the general manager's office of the Great Northern, assistant superintentdent and later superintendent of the Great Northern. In 1900, he went to the Erie as superintendent at Scranton, Pa., subsequently serving as superintendent of the Union Steamboat Line of the Erie, at Buffalo, N. Y., and as superintendent of the Allegheny division of the Erie. He returned to the Great Northern in 1903, as superintendent, and in 1905 was promoted to assistant general superintendent of the Central district. In 1907 he went to the Oregon Short Line as assistant general superintendent, and was subsequently made acting general superintendent and later general superintendent. In 1910 he was appointed general superintendent of the Central district of the Southern Pacific, with headquarters at San Francisco, Cal. He entered the service of the Baltimore & Ohio on January 1, 1914, as assistant general manager at Cincinnati, Ohio, of the Baltimore & Ohio Southwestern-Cincinnati, Hamilton & Dayton, and later in the same year was promoted to general manager of these lines. In July, 1916, he was appointed vice-president in charge of operation and maintenance of the Baltimore & Ohio System, with headquarters at Baltimore, Md., and held that position until July 1, 1918, when, under federal control of the railroads, he was appointed manager of the New York properties of the Baltimore & Ohio, including the Station Island lines. In September, 1919, he left the Baltimore & Ohio to become president of the Rock Hill Iron & Coal Company and associated corporations, including the East Broad Top Railroad & Coal Company, with office at New York.


J. M. Davis

The Keller Pneumatic Tool Company announces the removal of its Chicago branch to larger and more up-to-date salesrooms and service station. This branch is now located on the main floor in the Transportation building, 624 South Dearborn street, Chicago, where a complete stock of tools and parts will be maintained.

Fred H. Dorner, Wells building, Milwaukee, Wis., has been appointed sales representative for the American Spiral Spring & Manufacturing Company in Wisconsin and the northern peninsula of Michigan. McCreery & Taussig, Railway Exchange building, St. Louis, Mo., have been appointed sales representatives for the company in Missouri and southern Illinois.

The Jones & Laughlin Steel Company of Pittsburgh, Pa., has purchased 15 acres of ground with a 2,700-ft. frontage on Lake Michigan, just east of the Illinois-Indiana state line, near Chicago. This company already owns other land in the Calumet district and it is reported that plans are being made to build a steel plant in that district.

Robert L. Bridgman, New England representative of the L. S. Starrett Company, Athol, Mass., died suddenly on May 7, at the age of 87, at his home in Belchertown, Mass. Previous to 1908, when he became connected with the L. S. Starrett Company as New England representative, Mr. Bridgman served for over 30 years as representative of the Athol Machine Company.

Last January the interests, along with all patents and patent rights, of the Duntley Pneumatic Tool Company were acquired by the H. O King Company, engineers and tools makers of Chicago, at which time Mr. King, president of the H. O. King Company, organized the Duntley-King Pneumatic Tool Company. This new company is now in production on a full line of pneumatic tools and accessories, with general offices and factory at 1143 Diversey Parkway, Chicago.

J. A. Rittenhouse, superintendent of the Pullman Company, with headquarters at Philadelphia, Pa., has been transferred to Detroit, Mich., with jurisdiction over the Detroit, Buffalo and Cleveland districts. W. A. Hartley, assistant to the assistant general manager, with headquarters at Philadelphia, Pa., has been given jurisdiction over car movements and other matters local to the Philadelphia district. J. T. Ramsom, assistant general manager, with headquarters at Washington, D. C., has been given jurisdiction over all matters general in character, affecting the Philadelphia district.

E. C. Sattley, associated for 20 years with the Page Steel & Wire Company at Pittsburgh and Monessen, serving a large part of the time as general manager, has joined R. J. Jones, formerly manager, and Oliver G. Boyd, formerly secretary, of the Tube & Pipe Supply Company, in forming a new corporation under the name of the Iron & Steel Products Company, with offices at 230 Fifth avenue, Pittsburgh, Pa. The new organization will continue the business heretofore conducted by the Tube & Pipe Supply Company. E. C. Sattley is president, R. J. Jones, vice-president, and Oliver G. Boyd, secretary and treasurer of the new company.

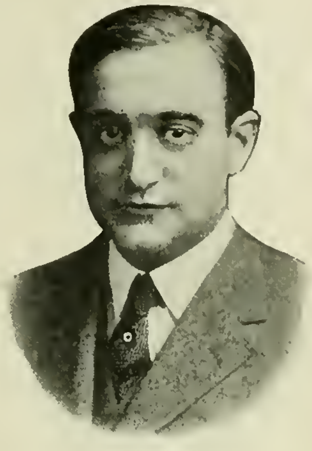
Wilber Eckels has been appointed western sales manager, with headquarters in the People's Gas building, Chicago, for the Standard Coupler Company, New York. Mr. Eckels graduated from Pennsylvania State College with the degree of mechanical engineer and has been with the Standard Coupler Company since 1912, with the exception of one year when he served as lieutenant in the 35th Engineers, A. E. F., in France and England. E. G. Goodwin has been appointed chief engineer of the same company, with headquarters at New York; vice R. D. Gallagher, Jr., resigned. Mr. Goodwin received his technical education in the Virginia Polytechnic Institute and has been connected with the Norfolk & Western in its engineering department for eleven years.

Harry W. Finnell has become connected with the sales department of the Automatic Straight Air Brake Company, with headquarters at the company's general offices, 210 Eleventh avenue, New York City. Mr. Finnell served with the Chicago Railway Equipment Company from 1906 to 1909 as railway sales manager and later became assistant to president of the Carbon Steel Company, Pittsburgh, Pa. In 1914, he was appointed general manager of the Henry Giessel Company, Chicago, and during 1915 and 1916 was vice-president of Templeton, Kenley & Co., Ltd., Chicago. He was manager of the War Industries Bureau for Illinois, and was also affiliated with the War Industries Board, since which time he has been in the export business.

Homer J. Forsythe, manager of the construction division of the engineering department of E. I. Du Pont de Nemours & Co., Inc., Wilmington, Del., has been transferred to the position of assistant general manager of the Hyatt Roller Bearing Company, Newark, N. J., a subsidiary of the General Motors Corporation. Mr. Forsythe has a wide experience in machine shop work, having been with the engineering department of the Du Pont Company since August, 1906, when he began work at the Wilmington office as estimator. Later he held executive positions at the Brandywine shops, Wilmington, and during the war he was made manager of the combined Wilmington shops which were engaged in the construction of material for the war plants. Since the war, Mr. Forsythe served as manager of the construction division of the engineering department.

Page Steel & Wire Company

A. P. Van Schaick has been appointed general manager of sales of the Page Steel & Wire Company, with headquarters in the Grand Central Terminal, New York, succeeding C. E. Sattley, resigned. Mr. Van Schaick began his business career in 1903, at which time he left Williams College, Williamstown, Mass., to enter the railroad sales department of the Pittsburgh Plate Glass Company, with headquarters in Chicago. From 1906 to 1910 he was in the employ of the Universal Railway Supply Company, with headquarters in the same city, resigning from that position during the latter year to become district sales manager of the Lackawanna Steel Company at Chicago. In May, 1919, he went to the American Chain Company, Inc., Bridgeport, Conn., as special representative, with headquarters in Chicago, and subsequently was appointed assistant general manager of sales of the same company at New York. On January 1, 1921, he was promoted to general manager of sales of the American Chain Company and other subsidiary companies, and now becomes also general manager of sales of the Page Steel & Wire Company. Mr. Van Schaick has been active in the work of railway supply organizations and especially of the national Railway Appliances Association. He was elected a member of the executive committee of this association in 1910, vice-president in 1911, and president the following year.


A. P. Van Schaick


W. T. Kyle

W. T. Kyle, who has been appointed assistant general manager of sales of the Page Steel & Wire Company, was born in 1883, at Baltimore, Md. He was educated in the high schools and took academic courses in various academies, specializing in civil engineering. In 1901 he began an apprenticeship course with the Bell Telephone Company at Philadelphia, Pa., and two years later went with the American Pipe & Construction Co., Philadelphia, as district superintendent, on general railroad construction work. He left that position in 1908, to go to the Duplex Metals Company, New York, as a salesman, and later became sales manager of the same company. In 1914 he went to the Okonite Company as special representative at New York. In 1916 he entered the service of the Page Steel & Wire Company as sales manager of its Armco wire department at New York and on April 1 was promoted to assistant general manager of sales, with headquarters at New York. All the company's general sales are now handled at New York for both the Adrian, Mich., and the Monessen, Pa., plants. Mr. Kyle served in 1917 and 1918 as chairman of the Railway Signal Appliance Association, and is now chairman of the Railway Telegraph & Telephone Appliance Association.

TRADE PUBLICATIONS

Coxe Stoker.—The Coxe stoker is described and fully illustrated in a 29-page booklet issued by the Combustion Engineering Corporation, New York. The results of economy and capacity tests on 1,000 hp. units are given, also coal analyses.

Easy-Cut Ground Taps.—John Bath & Co., Inc., Worcester, Mass., has recently issued an 8-page bulletin describing a precision tap which removes metal easily and produces an accurate threaded hole. A table of sizes established by the National Screw Thread Commission on Taps is included.

Stellite.—A new method of obtaining increased cutting speed, the latest advances in machine-tool practice, heat charts, tables and other data concerning Stellite tools, are included in two new textbooks recently issued by the Haynes Stellite Company, New York. The books are of convenient pocket size and are well illustrated.

Lateral.—The cause and effect of lateral play, also its remedy, are taken up in a clear and comprehensive manner in Catalogue No. 6, recently issued by the Smith Locomotive Adjustable Hub Plate Company, Chicago. Illustrations and a chart, showing the design of plate, width of bore, and other details of application, complete the book.

Boring Machines.—An instruction booklet, issued recently by the Universal Boring Machine Company, Hudson, Mass., contains 37 pages devoted to the setting up, leveling and operation of Universal horizontal boring machines made by this company. Detailed illustrations show the possible adjustments and proper methods of operating these machines with red arrows indicating the cautions to be observed.

Automatic Lowering Jacks.—The Duff Manufacturing Company, Pittsburgh, Pa., is distributing a new bulletin, No. 308, which illustrates and describes their line of automatic lowering jacks. This type of jack, which is made in a wide variety of heights, especially suitable for use in car repair shops and bridge work, is adapted for raising loads of any kind where a lifting capacity of 25 tons or less is required.

Vanadium.—A 50-page book on Vanadium, In War and Peace, has been issued by the Vanadium Corporation of America, New York. After a brief outline of the early history of vanadium and an interesting description of the ore supply at Mina Ragra, Peru, numerous illustrations and suggestions for the application of the finished product are given, also two charts showing the physical properties of vanadium steel at different draw-back temperatures.

Alloy Steels.—Joseph T. Ryerson & Son, Chicago, have recently published a 95-page booklet on the heat treatment of alloy steels, entitled "The Ryerson Handbook on Alloy Steels." The book is written in an accurate and interesting, but non-technical style, and covers in separate chapters the quality, manufacture, heat treating and testing of alloy steels, as well as many other features, including a description of quenching equipment, furnaces, etc., and specifications.

Water Softeners.—Refinite, a substance for softening water in textile mills, laundries, institutions, hotels, etc., and the Booth lime soda water softener, especially adapted for the use of railroads, municipalities, and the larger steam power and central heating plants, are each described in detail in separate treatises recently issued by the Refinite Company, Omaha, Neb. A number of illustrations showing the construction and typical installations of each of these systems are contained in these catalogues.

Grinding Machines.—A general description, specifications, illustrations and lists of attachments and repair parts for Bath Universal grinding machines are given in a well-arranged catalogue of 18 pages recently issued by the Universal Grinding Machine Company, Fitchburg, Mass. The massive proportions of the bed, column, knee, table, etc., the wide range of work and traverse speeds, liberal bearings, the accuracy of the automatic feeds, and the centralized location of operation at the front of table are some of the interesting features explained.

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CONTENTS

EDITORIAL:

Overhaul the Old Machines.. 415
Roundhouse vs. Back Shop Repairs.. 415
Wages, Cost of Living and Productive Efficiency.. 416
Centralized Production Shops Needed 417
A Need for Fundamental Data.. 417
The Foot-Pound versus the Horsepower.. 418
Maintenance Cost of Combustion Chambers.. 418

GENERAL:

Consolidation Locomotives for the Western Maryland.. 419
Annual Convention of the Fuel Association.. 423
Virginian Demonstration of Double-Capacity Brake.. 428
Suggestions for Improvements in Locomotives.. 434

CAR DEPARTMENT:

Draft Gear Tests of the Railroad Administration.. 435
Means of Preventing Hot Boxes.. 440
Modifications in Rules Proposed by C. I. C. I. & C. F. A.. 441
Insulation of Freight and Passenger Cars.. 444

SHOP PRACTICE

Oxy-Acetylene Blowpipes 449
Cost of Air vs. Steam for Operating Hammers.. 450
Manufacturing Standard Locomotive Repair Parts.. 451
Pneumatic Grease Gun 455
Electric Arc Welding in Railroad Shops.. 456
The Use of Gas in Railroad Shops.. 458
The Foreman; His Qualifications and Training.. 459
Holder for Side Rods and Drawbars.. 461

NEW DEVICES:

High Power Vertical Turning and Boring Mill.. 462
Expanding Internal Thread Micrometer 463
Sixty-Inch Lathe of Exceptional Power.. 464
Rail Washer Reduces Flange and Rail Wear.. 465
A Positive Mechanical Journal Lubricator.. 466
Lightweight Shovel of Sturdy Construction.. 467
Ease of Operation Features New Coach Seat.. 467
Automatic Exhaust Pipe and Blower Valve.. 468
Portable Electric Grinder with Pistol Grip.. 469
Driving Box Grease Groove Arrangement.. 469
Self-Opening and Adjustable Die Heads.. 470
Franklin Precision Power Reverse Gear 470
Long Distance Recording Thermometers 471
Safety Hand Brake Stands Severe Tests.. 472
Storage Battery Truck Equipped with Crane.. 472

GENERAL NEWS:

Notes 473
Meetings and Conventions 474
Personal Mention 474
Supply Trade Notes 475
Trade Publications 476

Overhaul the Old Machines

Railroad shop and roundhouse men have become adepts in making the most of the machine tools and shop equipment available, usually finding some way to accomplish the results desired no matter how great the handicap. Old equipment is a serious drawback, however, especially if out of repair, and some men do not fully realize the present need and possibility of tuning up all shop machinery for greater production. Many old machines are too antiquated to be of value except for scrap but, on the other hand, the arrangement for more powerful drive, increasing speed or feed range, or strengthening some weak point may improve certain machines and make them real production tools. Advantage should be taken of the present opportunity to bring shop and enginehouse machinery and equipment up to the best possible state of repair. Repair gangs can be organized and taught the importance of careful, periodical inspection and repair. This will enable machines to be kept in operation with the fewest possible delays, and in certain cases the discovery of a weak or worn part will enable this part to be replaced, thus preventing a breakdown during some subsequent rush period. A great saving can be effected by developing and keeping in good repair time-saving jigs and fixtures which have demonstrated their value in actual service. Careful judgment should be used in the manufacture of these jigs because it is possible to go into refinements which are in no way warranted. The initial cost must always be balanced against the amount of work and possible savings. The recent government valuation showed a great abundance of small tools of all sizes, kinds and conditions of usefulness and it is apparent that real economy can be effected by a little attention to the determination of standards for these tools which are shown by experience to be satisfactory.

Roundhouse vs. Back Shop Repairs

It is important to maintain accurate figures regarding the cost of operating and maintaining cars and locomotives in order that equipment may be handled in such a way as to produce a maximum return for every dollar invested. The case cannot be put more plainly than was done recently by a prominent mechanical engineer in discussing running repair work which should be handled in roundhouses as against back shops. He said, "On some railroads it is a commonly accepted belief that minimum repair costs are attained by keeping equipment, particularly locomotives, in service as long as possible between shoppings. Other roads follow the practice of shopping locomotives oftener and doing little mechanical work on them in the roundhouse. It is not uncommon on a railroad, which follows to extremes the practice of keeping locomotives out of the shop as long as possible, to see work properly belonging under the head of heavy repairs done piecemeal in the roundhouse, care being taken to see that the cost of work done at each interval does not exceed the amount allotted for light or running repairs. There is obviously a limit beyond which such a policy cannot be pursued without making repairs cost more per dollar earned than would be necessary if locomotives were shopped at reasonable intervals. The repairs could then be more conveniently and thoroughly made without unnecessary repetition of such operations as tearing down and reassembling parts. The limit at which roundhouse repairs cease to be profitable should be determined separately for different railroads. This limit will probably be different for different types or classes of power, and also for different parts of the same railway system. The mechanical department should determine such a limit for each type or class of power and be guided by it in formulating the policy of the road as regards locomotive repairs."

Wages, Cost of Living and Productive Efficiency

During the long controversy over wage rates, many arguments were presented regarding comparative wage scales and other factors on which wages are based under the Transportation Act. Fundamentally, however, the wages paid and the purchasing power of these wages depend on the production of all classes of workers. At the present time it is particularly important that this matter be thoroughly understood, and an editorial which appeared recently in the Railway Age dealing with some phases of this subject is therefore reprinted below.

In the recent wage hearings before the Railroad Labor Board some of the labor leaders protested against the policy of changing wages according to changes in the cost of living. The American Federation of Labor at its convention in Denver adopted a resolution denouncing the basing of wages wholly or mainly on the cost of living as "a violation of the whole philosophy of progress and civilization and a violation of sound economic theory and thoroughly without logic or scientific support."

Most of the advances in wages which have been made in this country since before the war have been based on increases in the cost of living. This has been especially true in the railroad business. Labor leaders were glad to accept advances in wages based on the cost of living when it was increasing. They repudiate the principle now that the cost of living is declining.

Having secured great advances in wages based on increases in the cost of living, the labor leaders cannot hope to prevent all reductions when it is declining. The cost of living is declining because prices are declining. Prices are declining because there is reduced demand for commodities at the high prices which have prevailed. Wages must be reduced when prices sharply decline, because employers cannot pay war wages when they can get only pre-war prices without being bankrupted. In many industries the wages being paid exceed the total earnings of those industries when lower prices and rates were in effect a few years ago. In the railroad industry, for example, the total wages paid in 1920 exceeded the total earnings of 1916. The restoration of pre-war prices means in many industries restoration of pre-war earnings. No industry can pay to labor all it earns.

However, while in a period when prices are falling so much wages must come down, just as in a period when prices are greatly advancing they must go up, the labor leaders are on a sound economic ground when they condemn the practice of basing wages wholly or mainly on the cost of living. A large majority of the people of the world work with their hands. If wages were always to vary directly with the cost of living, the working people never would get for their work an increased amount of comforts and luxuries. This would mean that working people would derive no benefits from the material progress of civilization. If a large majority of the people derived no benefit from it, this so-called "progress" would be misnamed.

Upon what, then, should wages be mainly based? They should be mainly based on productive efficiency. Capital furnishes the directing brains, the physical plant, the tools, of industry. Working people furnish the manual skill and labor. Both should constantly increase their efficiency. The increasing efficiency of both will result in a constantly increasing product in proportion to the capital invested and the number of workers. Equitable division of this increased product would and should result in increasing returns to both.

Increases of industrial efficiency and output will, however, be seriously hindered or prevented if either of the partners in industry, capital and labor, constantly tries to defeat all efforts of the other partner to secure increases of efficiency and output. This is virtually what is being done in many industries now. Capital is constantly trying to increase production in proportion to the amount invested and the men employed. The members of many labor unions, under reactionary leadership, are just as constantly trying to prevent increases of output. These reactionary leaders are sometimes called "radicals." They are, in fact, the most reactionary men in civilized countries. If they should accomplish all they attempt, the efficiency of modern industry would be destroyed and its output so reduced that every workingman's family would suffer curtailment of its comforts and luxuries. These labor leaders restrict the number of brick that men can lay; they insist upon classifications which increase the number of men employed to do a given job; they exhaust their ingenuity in devising ways to curtail not only the number of hours which men work, but the amount each does in each hour he does work. Every measure of this kind tends to reduce the number of houses built, the number of suits of clothes made, the quantity of food produced, the amount of transportation rendered.

No better examples of the results of these labor union tactics could be cited than are afforded by developments in recent years on the railroads of this country. Until 1917 there was a steady increase in the amount of transportation service rendered in proportion to the number of men employed. Since then, while wages have been greatly increased, the output per employee has sharply declined.

In 1913 the amount of public service rendered for each dollar of interest and dividends paid to owners of railway securities was 459 ton-miles and 47 passenger-miles. In 1917 it was 582 ton-miles and 53 passenger-miles. In 1920 it was 611 ton-miles and 64 passenger-miles. The increase between 1913 and 1920 in freight service rendered for each dollar of return paid to capital was 33 per cent and in passenger service 36 per cent. Contrast these statistics with the following regarding the production of transportation to the wages paid: In 1913 for each dollar of wages paid the railroads rendered 245 ton-miles of freight service and 25 miles of passenger service; in 1917, 247 ton-miles and 22 passenger-miles; in 1920, only 121 ton-miles and 13 passenger-miles of service. The decrease in transportation output for each dollar of wages paid between 1913 and 1920 was about 50 per cent.

The Railway Age pointed out months ago to labor leaders and their followers that the only way they could hope to retain all, or even a large part, of the advances in wages made since before the war was through increased efficiency. High wages and low efficiency for any considerable time always have been and always will be incompatible in any industry. The labor leaders having, however, obtained rules, hours and working conditions from the Railroad Administration which greatly reduced the efficiency and output of the average employee, sought to perpetuate instead of to eliminate, to aggravate instead of to mitigate, the rules and conditions which produced the demoralization. They sought at the same time to maintain a scale of wages which was incompatible with the gross inefficiency that prevailed. They tried to both eat their cake and have it. The result was to force up railroad rates and at the same time bring the railroads to the verge of bankruptcy. Largely in consequence of these things, 500,000 railway men have speedily found themselves out of employment, and now $400,000,000 of the wage advances has been ordered rescinded.

The labor leaders are right—wages should not be based entirely or mainly on the cost of living. Furthermore, in the long run they cannot and will not be. Efficiency of production always has and always will, in the long run, bring advances in wages largely regardless of the cost of living. Inefficiency of production always has and always will, in the long run, bring reductions of wages largely regardless of the cost of living. The highest wages in proportion to the cost of living are, and always will be, paid in those countries where the efficiency of capital and labor are the greatest. The lowest wages in proportion to the cost of living are and always will be paid in those countries where the efficiency of capital and labor are the lowest. In the United States wages will increase more than the cost of living in the future as they have in the past if the productive efficiency of capital and labor increases, and decline more than the cost of living if efficiency declines.

Most of the present generation of labor leaders are engaged constantly in trying to reduce wages in proportion to the cost of living by trying to reduce productive efficiency. They may be unconscious of it, but this is what they are doing. Some time, perhaps, the workingmen will choose leaders who recognize not only the truth that wages should not be based on the cost of living, but the additional truth that in the long run they always have been and always must be based upon productive efficiency. The worst enemy the workingman has is the man who exhausts his ingenuity and energy in trying to reduce the amount of efficient work that workingmen do.

Centralized Production Shops Needed

While most railroads are not financially in a position at the present time to establish centralized production shops, railroad men are coming to realize more and more the need for this important department. Arrangements for handling duplicate machine operations in one central department enable highly productive, specialized machines to be segregated at this point and effect economies in manufacture that can be obtained in no other way. Elsewhere in this issue is an article entitled, "Manufacturing Standard Locomotive Repair Parts," which is devoted to a consideration of this subject, and gives methods of standardizing small repair parts and determining proper step sizes, together with approved practices in the manufacture of these duplicate parts.

The centralized production shops must be prepared to furnish parts in a finished or semi-finished state for distribution to the stores department and subsequently to shops and engine houses throughout the system. Two benefits result from this practice. Not only are the parts manufactured in bulk at a minimum cost, but when they can be secured at local shops and terminals in a finished or semi-finished condition, very little time is required to fit them to the locomotive or car in question. Equipment is, therefore, repaired and returned to service in a minimum length of time and this effects important economies since the first cost of locomotives and cars is so high that every hour they are unnecessarily held out of service reduces the revenue earned and allows interest and depreciation charges to accumulate.

It is pointed out in the article that motion work pins and bushings, axles, crank pins, valve motion levers, crossheads, piston rods and other parts too numerous to mention may be machined from the rough casting, forging or bar stock to a finished or semi-finished state. Machine operations on most of these parts can be performed to good advantage in centralized production shops, but operations involving single set-ups, such as some planing jobs and most lathe work can be done as cheaply in one place as another. The necessity of standardizing thread sizes is pointed out; this is important because parts manufactured in the central shop will find their way to different shops and engine houses, and in many cases will be of absolutely no use unless the thread sizes are interchangeable. It is understood that thread standardization cannot be obtained without suitable internal and external thread gages of the Go-and-Not-Go type, used in conjunction with master reference gages.

The importance of grinding operations in central shops is stressed throughout the article. Many advantages result from the use of grinding machines, experience having demonstrated that greater accuracy and a better finish are secured in a shorter time by grinding than by any other method. In addition the fact that the finished operation is to be performed by grinding enables heavier cuts to be taken by the automatics, with resultant increased production. As in the case of external grinders it is important to have rugged machines for internal grinding. A chucking equipment is preferred and the machine should have ample belt power and rigidity to remove metal quickly. By the use of production internal grinders the cost of grinding the bores of bushings will be more than offset by the advantages of accuracy and interchangeability.

A Need for Fundamental Data

The history of agricultural development in the United States presents a broad parallel to the development of railway transportation. Beginning with vast undeveloped resources, of fertile soil in the one case and of revenue resources in the other, the early development in each case was extensive and not intensive; there was little need for attention to efficiency in the utilization and exploitation of these resources. Any seed placed in average soil will grow. But there is a vast difference between the growing of crops on this simple basis and the scientific farming now becoming so general, by which the forces of nature are controlled through accurate, scientific knowledge of soils and fertilizers, of seed quality and of plant and insect life, in order that the soil resources may be made to produce the maximum of return and at the same time be retained unimpaired for the future. Given a locomotive—any locomotive—, a car—any car—, and a track—any track provided it is strong enough to hold up the locomotive—, and traffic can be moved. But there is a vast difference between this simple railroad and the type of well-balanced transportation machine which is required to move traffic with the high degree of efficiency that present conditions demand if the net return is to be sufficient to insure it an unimpaired future existence.

Unfortunately, the degree of science which has been developed with the growth of the transportation industry will not compare favorably with that in the field of agriculture. Science is founded on facts and the fund of fundamental facts pertaining to the railroad business is still far from adequate. It is true that through the reports of the carriers to the Interstate Commerce Commission a large amount of invaluable data have been gathered but these are general in character and leave many specific problems untouched.

One of the most important of these problems so far as the mechanical department is concerned is the economics of freight car design, operation and maintenance. Freight cars are built by the thousands and, unfortunately, very little broad study is given to them. There are many phases of the freight car problem susceptible of scientific study by the railroads individually without awaiting the attention of a central agency such as the Interstate Commerce Commission or even the American Railway Association. For instance, how many railroads have ever attempted to determine the most economical rate of depreciation so that when capital turnover is balanced against the average annual cost of maintenance throughout the life of the equipment, the minimum charges to operating expenses may be obtained? How many railroads know just what proportion of the total cost of maintaining their freight cars is chargeable to any specific series of cars? The answer to these questions are not difficult to obtain. Indeed, it is probable that all of the basic data required are now available, awaiting only the proper classification and analysis.

It is true that such a classification and analysis would involve an outlay, but an outlay so small in proportion to the expenditures involved that it is inconceivable that a hundred-fold return would not be obtained by the ability to form sound judgments on a foundation of facts which such studies would make possible, instead of on the basis of more or less unsupported personal opinion and prejudice as is necessary at present. With thousands of weak and unsuitable freight cars persistently retained in service, in many cases against the better judgment of mechanical department officers, would it not pay them to introduce such studies at the present time?

The Foot-Pound Versus The Horsepower

When mention is made of "the characteristics of the steam locomotive" one immediately visualizes the drawbar pull-speed curve and the horsepower-speed curve, showing respectively the maximum drawbar pull and the maximum horsepower which the locomotive is capable of developing at all points within the full speed range of the locomotive. These characteristics undoubtedly are of value for the comparative study of locomotive designs, but when considering the service which a freight locomotive is to render, the less frequently discussed area which lies under these two curves becomes a matter of great interest.

As commonly operated, the freight locomotive is a producer of work rather than a producer of power. The problem is one of performing a definite amount of work within a fixed distance, in which the element of time ceases to be a factor at the point where overtime no longer has to be paid. Since the fuel cost is about equal to the cost of crew wages in freight train operation, fuel economy in the production of the unit of work becomes a matter of greater interest than the maximum horsepower capacity which the locomotive is capable of developing and the effect of speed on the fuel consumption per unit of work must be as carefully considered as its effect on punitive overtime.

By inference, the use of the horsepower as the unit of capacity for freight locomotives leads to the assumption that this capacity may be utilized to equal advantage irrespective of the speed at which it is attained. From the standpoint of maximum horsepower capacity the highest fuel economy is not attained at speeds much below 30 or 35 miles an hour, when the maximum horsepower is developed. From the standpoint of work, measured in foot-pounds, it is recognized in every-day practice that a given tractive effort may be maintained most economically at speeds considerably below the highest at which that tractive effort can be maintained.

Data from locomotive tests confirm practical experience in this respect and show that the maximum horsepower capacity at a given tractive effort can be obtained only at the expense of a sharp increase in fuel consumption per million foot-pounds of work within a comparatively small range of speeds. A Mikado type locomotive capable of developing about 65 per cent of its starting tractive effort at 25 miles an hour does so with an increase in fuel consumption of about 55 per cent over the amount required to maintain the same tractive effort at 15 miles an hour and with a 36 per cent increase over the amount required at 20 miles an hour. For this same locomotive there is also a tendency, although much less pronounced, toward an increase in the fuel consumption per unit of work when speed increases are obtained by reducing the tonnage and the cut-off is maintained constant.

These facts are indicative of some of the characteristics of the steam locomotive when operating under conditions which lie in the comparatively uncharted area under the commonly used characteristic curves. Since they are of great practical importance in the actual application of the freight locomotive to the production of ton-miles, it is suggested that in analyzing test results and locomotive operation in general, the locomotive be regarded more in the light of a work producer than of a power producer. This will lead to a more accurate estimation of ton-mile fuel costs as a factor in determining the best methods of utilizing freight locomotive capacity, without detracting in any way from the attention to be given to speed so far as it affects the wage costs.

Maintenance Cost of Combustion Chambers

Some American railroads have for many years constructed locomotive boilers with combustion chambers. During the last five years their use has become quite general on nearly all roads burning high volatile coal and in most cases the results have been satisfactory. However, combustion chambers, like all other locomotive appliances, have certain disadvantages. Some roads have experienced considerable trouble with cracking of the plates in the combustion chamber and some mechanical officers have proposed to eliminate the combustion chambers to overcome this difficulty.

As the economy of combustion chambers is now being questioned, it may be pertinent to review the results of investigations to determine the benefits derived from this type of construction. In a locomotive burning an average grade of bituminous coal under ordinary conditions of firing over 50 per cent of the heat generated in the firebox is due to the burning of the gases in the fuel. To obtain full heating value from the volatile matter in the coal, the gases of combustion must be given time to mix with oxygen at a high temperature. This can only be done by lengthening the flame passage by baffles in the firebox, or by increasing the volume through the use of combustion chambers. With bituminous coal and high rates of combustion, both methods must be utilized if reasonably good boiler efficiency is to be obtained.

Tests of similar locomotive boilers with and without combustion chambers showed that the boiler without the combustion chamber reached its maximum capacity at a rate of combustion of 135 lb. of coal per square foot of grate per hour, while the capacity of the boiler with the combustion chamber continued to increase even at a rate of 160 lb. At a rate of combustion of 135 lb. the furnace efficiency of the boiler without the combustion chamber was only 62 per cent, while with the combustion chamber it was 74 per cent.

The saving in fuel effected by the combustion chamber is so large that it would probably far outweigh the increased cost of repairs in any boiler of reasonably good design. Frequent cracking of the combustion chamber sheets is probably due to too rigid construction which under ordinary conditions can be overcome quite readily by the use of flexible staybolts. Another important cause of failure may be the poor material that has been accepted under the specifications prepared during the war. However serious the trouble may be, an attempt should be made to determine the cause and correct it in order to avoid sacrificing the improved boiler efficiency which is obtained by the use of combustion chambers.

The Illinois Central made a record for passenger train performance during the month of May, when a total of 13,567 trains were operated, 13,461, or 92.2 per cent., of which maintained scheduled time.

Photo by International

Consolidation Locomotives for the Western Maryland

Weight and Tractive Effort Establish New Records for This Type—Tender of 15,000 Gallons Capacity Used

THE design of locomotives adapted to special operating conditions has led to the development of some notable examples of the standard types of freight and passenger power. A striking illustration of the high tractive effort that can be secured with a restricted wheel base is found in the Consolidation locomotives recently built for the Western Maryland by the Baldwin Locomotive Works. These engines have a rated tractive effort of 68,200 lb., the weight on drivers being 268,200 lb. or 67,050 lb. per pair of drivers. In these particulars they exceed any engines of either the Consolidation or Mikado types heretofore constructed by the builder.

During the past ten years the Consolidation has been largely displaced by the Mikado and in view of the selection of the former type by the Western Maryland, a brief discussion of the advantages and disadvantages of each may be of interest.

The Consolidation type locomotive was introduced in this country in 1866, the first engine of this type having cylinders of 20 in. diameter and 24 in. stroke, and a total weight of 90,000 lb. The Consolidation wheel arrangement is well adapted for general freight service and following its introduction was widely adopted, being for many years the prevailing type of freight power. About twelve years ago the Mikado began to displace the Consolidation and comparatively few of the latter type have been built for heavy freight service in recent years. The principal advantage of the Mikado lies in the fact that the longer wheel base, with a trailing truck, permits the use of a longer boiler barrel and a deeper firebox, thus improving the capacity and efficiency of the boiler. The Consolidation, however, can be designed to give equally high tractive effort at low speeds where the boiler capacity is not the limiting factor. The absence of the trailing truck eliminates certain maintenance costs and the non-symmetrical wheel base is easier on the track.

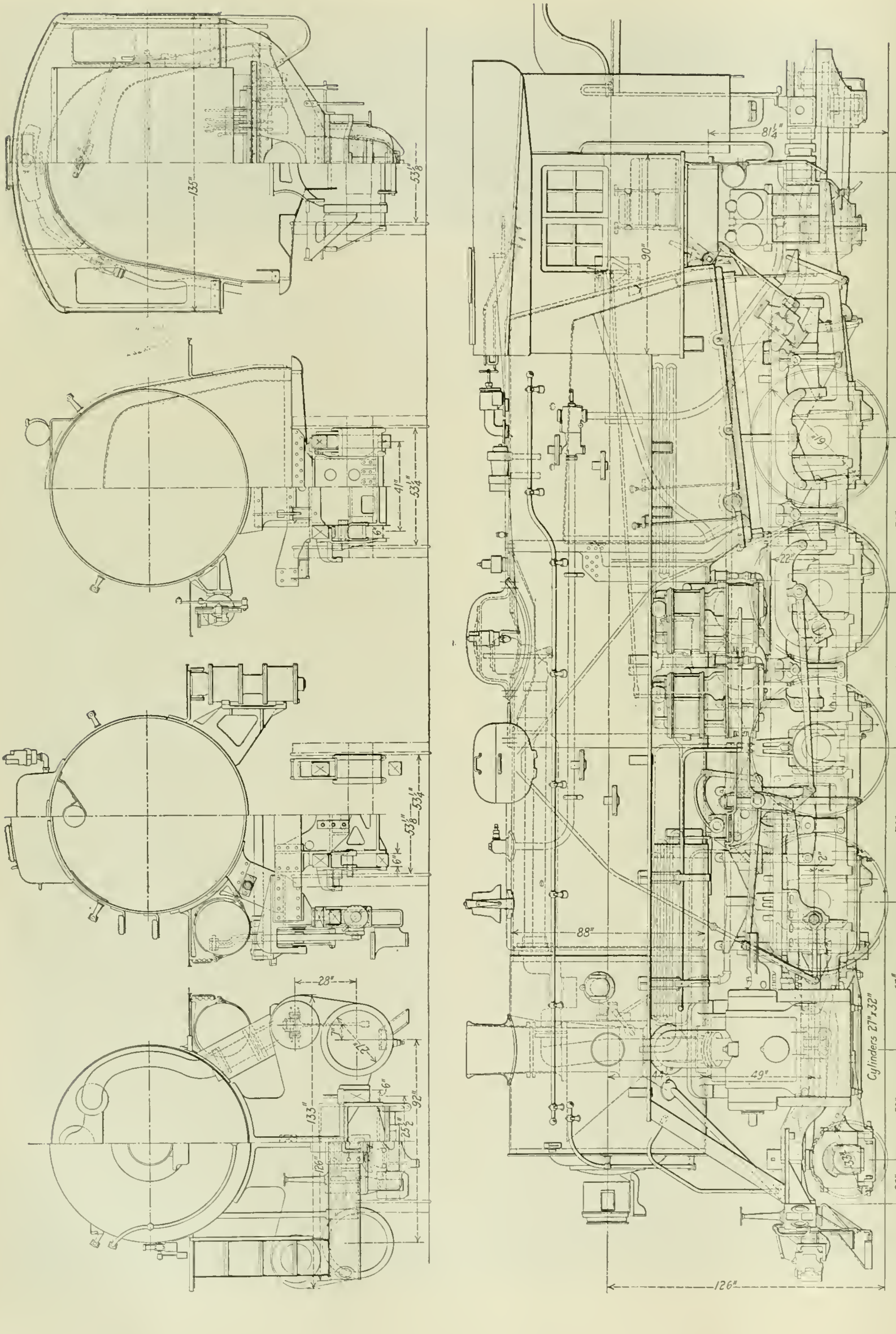
The improved utilization of fuel and higher speed capacity have generally been considered to outweigh the disadvantages of the Mikado. However, Consolidations are still used to a considerable extent for heavy drag service where slow speeds will suffice. With driving wheels of the size that are suitable for work of this kind, it is possible in a Consolidation engine to obtain a reasonably good boiler design. The firebox throat can be made of sufficient depth to install a brick arch without raising the boiler to an excessive height. Such a locomotive, with a high percentage of total weight on driving wheels, is well fitted for heavy, slow speed service.

The Consolidation engines which the Baldwin Locomotive Works are now building for the Western Maryland are a remarkable example of locomotives for such work. These engines are designed to operate on 90 lb. rails, to traverse curves of 22 deg. and grades of 3½ per cent. The total weight is 294,900 lb., while the weight on drivers (268,200 lb. total or 67,050 lb. per pair of drivers) and tractive effort (68,200 lb.) exceeds that reached in any Mikado or Consolidation type locomotives heretofore. The ratio of adhesion is 3.93, indicating that the weight on drivers is utilized for tractive purposes to the fullest possible extent. As compared with a design of heavy Consolidation built for the Western Maryland in 1910 and using saturated steam, these new locomotives show an increase in total weight of 31 per cent, and in tractive effort of 40 per cent.

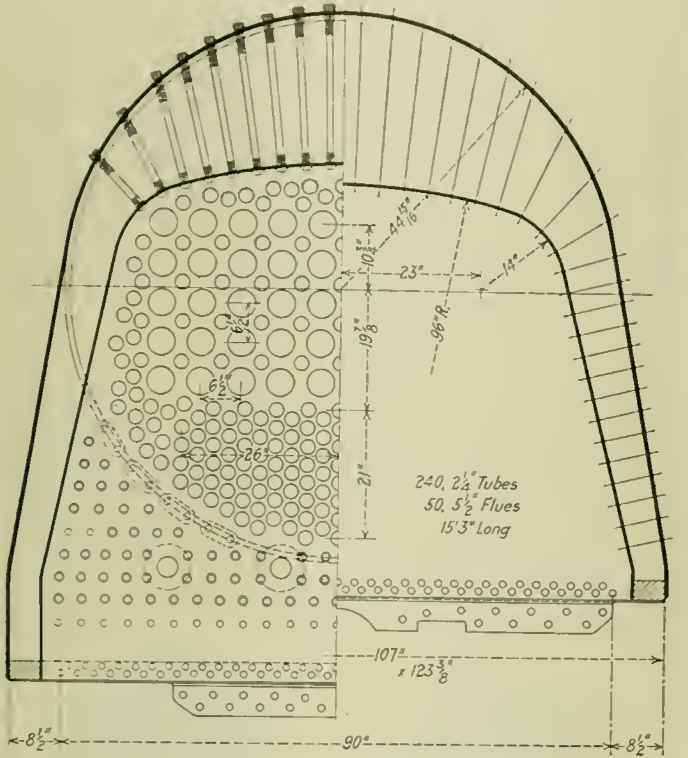
The boiler is of the straight top type with horizontal roof sheet and sloping throat and back head. The diameter of the first course of the barrel is 88 in. The throat has a depth of 19 13/16 in., measured from the under side of the barrel to the bottom of the mud ring. The firebox is supported at the front and back on vertical plates. The front end of the crown is supported on three rows of expansion stays, and about 550 flexible staybolts are applied in the breaking zones in the sides, throat and back. The distance between the tube sheets is 15 ft. 3 in. Fifty superheater tubes of 5½ in. diameter and 240 water tubes of 2¼ in. diameter are used. The ratio of length to internal diameter in the water tubes is 91.5, this low value indicating that the capacity of the boiler has been made high at some sacrifice of fuel economy. The safety valves are placed just forward of the firebox and as the clearance is limited, they are tapped directly into the boiler shell instead of being mounted on an auxiliary dome.

The firebox equipment includes a brick arch, power operated fire-door and grate shakers and a Standard stoker. The drop plates are at the back of the grate. The ash pan has two hoppers with swing bottoms, both of which are controlled by one handle. Flushing pipes are applied for washing ashes from the slopes of the pan.

The frames are 6 in. wide, spaced 41 in. between centers, each frame being cast in one piece with a single front rail to which the cylinders are bolted. The transverse bracing calls for special attention. A most substantial steel casting, placed just back of the cylinders, extends the full length of the leading driving pedestals and serves as a fulcrum for the driving brake shaft. The guide yoke crosstie is also of cast steel and it is extended back sufficiently far to brace the sec-

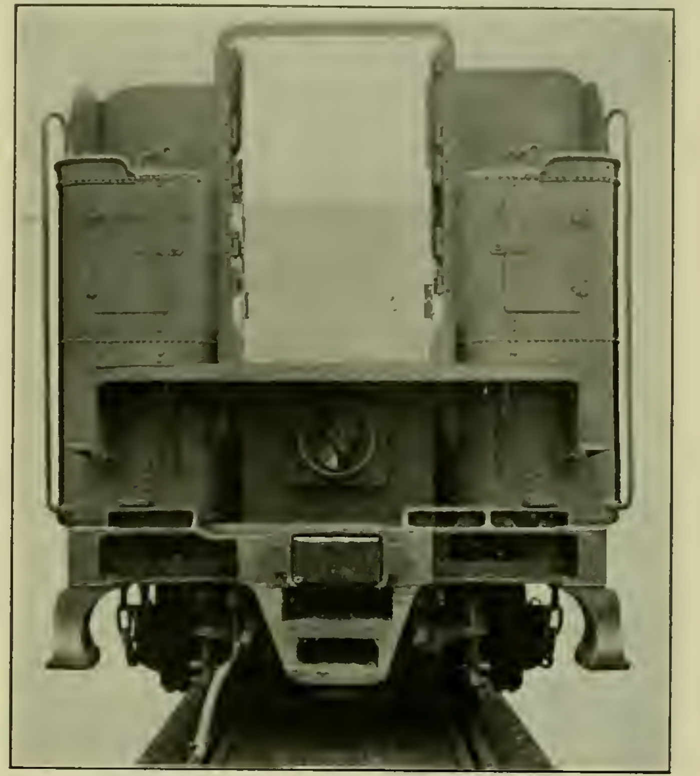


Side Elevation and Cross Sections of the Western Maryland Consolidation ond driving pedestals. This crosstie also serves as a support for the driving brake cylinders, one of which, because of lack of room, is placed in a horizontal, and the other in a vertical position. The two brake shaft arms are placed at right angles to each other, the horizontal cylinder being connected to the vertical arm by means of pull rods, while the vertical cylinder is directly connected to the horizontal arm. The frame braces further include a steel casting at the main driving pedestals and a casting, placed between the main and rear pedestals, which is bolted to both the top and bottom frame rails and serves as a support for the forward end of the firebox.

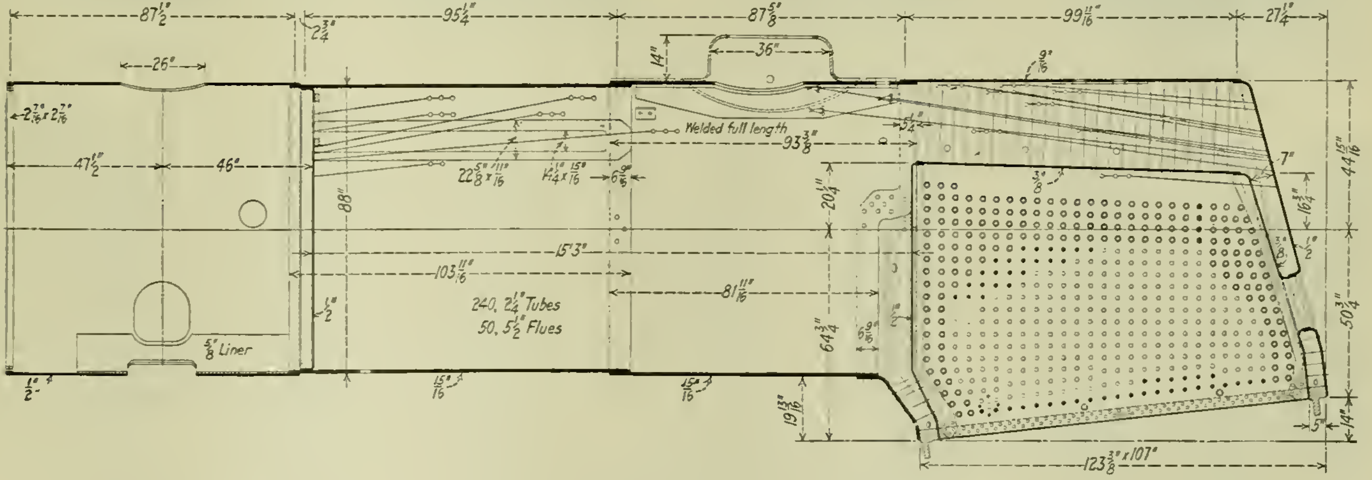


Cross Sections Through the Firebox

The cylinders are fitted with gun iron bushings, and the steam distribution is controlled by 14 in. piston valves. Walschaert valve motion is used and the gears are controlled by the Pittsburgh power reverse mechanism. The equipment includes automatically operated drifting valves designed by the railway company. The links are carried on longitudinal supports of cast steel, which are bolted in front of the guide bearers, and at the rear to a crosstie placed between the second and third pairs of drivers. The reverse shaft is located immediately in front of the links and the lifting arms extend in a backward direction, each radius rod being suspended at its rear end. The valve motion is so designed that the link blocks are down when running ahead. Other machinery details include cast steel piston heads of dished section with cast iron bull rings and packing rings. The guides and crossheads are of the Laird type. The main rod stubs are of the open end type which permits renewing the brasses without removing the eccentric cranks.



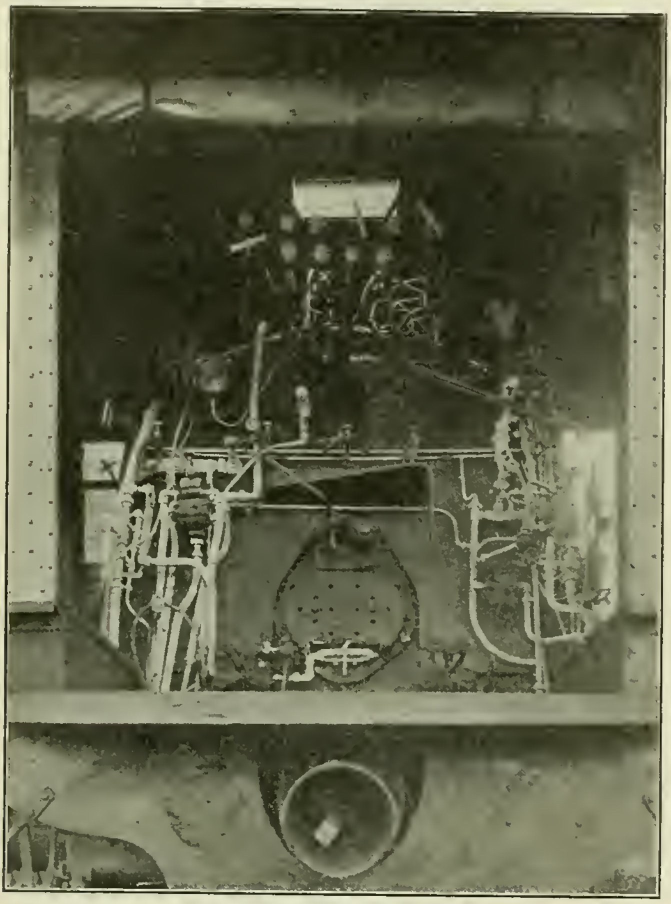
Front View of the High-Capacity Tender



Boiler of the Western Maryland Consolidation

The driving boxes are of cast steel and are fitted with bronze hub faces and brass lined pedestal faces. Cast iron shoes and wedges are used, the latter being of the self-adjusting type. The driving axles and engine truck axle are of heat treated steel, and flanged tires are used on all the wheels. Both front and back drivers have flange oilers.

The truck is of the Economy constant resistance type and is equalized with the first and second pairs of driving wheels. Dolphin beams are placed over the boxes on the third and fourth pairs of drivers and are connected on each side of the locomotive with three inverted leaf springs which are placed below the upper frame rail. Limited clearance space under the firebox did not permit placing the springs over the boxes of the two rear pairs of wheels.



Breather Pipes for Use in Tunnels Are a Novel Feature of the Cab Equipment

The cab is unusually roomy and comfortable with all fittings placed within convenient reach of the crew. The injectors and steam turret are placed outside the cab and have extension handles identified by small aluminum plates with raised letters. The equipment includes a breather pipe for providing fresh air while passing through tunnels. This arrangement consists of a ½ in. pipe placed across the boiler back head and having five ¼ in. globe valves equally spaced, each fitted with 3 ft. of ½ in. hose. The air supply is drawn from the brake system.

An interesting detail is the arrangement of the hand rail columns, which are in the form of clamps, so that the hand rail can be readily taken down without removing the columns. The headlight dynamo is placed on the right hand side of the boiler, ahead of the cab, and the wiring is run through the hand rail. The pilots are adjustable as to height above the rail and are of short design so that two locomotives can be coupled pilot to pilot without interference.

The tenders of these locomotives are of special interest, having the unusual capacity of 15,000 gal. of water and 16 tons of coal. The tanks are comparatively long and low in order to keep the center of gravity as low as possible. The extreme length of the tank is 36 ft. 6 in. and the width 10 ft. 5½ in., while the depth is 6 ft. 6 in. with a collar 32 in. high on each side of the fuel space. The sides and rear of the fuel space are sloped so that the coal will gravitate into the stoker trough even when only a small amount is on the tender. The stoker trough is constructed so that it may be removed as a complete unit even when the tender has a full load of coal. An unusually complete arrangement of transverse and longitudinal dash plates is applied to prevent the water from surging.

The frames are of one piece cast steel construction made by the Commonwealth Steel Company. The total length is 38 ft. 8 in. and the width over outside sills is 8 ft. 11¼ in. The distance between truck centers is 22 ft. 11¾ in.

The trucks are of the six wheel type, manufactured by the Commonwealth Steel Company. The truck frames are constructed with longitudinal and transverse members of steel, cast in one piece. The pedestals are bolted to the frames and the wheel loads are equalized on each side. Swing bolsters are used and are hung on three-point suspension links. The brakes are of the clasp type. It is found in practice that these tenders take curves smoothly and are very easy riding.

The locomotives have a height of 15 ft. 10 in., a width over cab boards of 11 ft. 4 in., and a total length of engine and tender, measured from face to face of beams, of 80 ft. 4¾ in. Their leading dimensions, in comparison with those of a number of heavy Consolidation type locomotives built during the past few years by the Baldwin Locomotive Works, are given in the accompanying table.

COMPARISON OF RECENT TYPES OF CONSOLIDATIONS

	Pennsylvania Lines	Union Railroad	Bessemer & Lake Erie	Lake Superior & Ishpeming	Philadelphia & Reading	Western Maryland
Cylinders	26 in. by 28 in.	25 in. by 32 in.	26 in. by 30 in.	26 in. by 30 in.	25 in. by 32 in.	27 in. by 32 in.
Valves	Piston 14 in. dia.	Piston 12 in. dia.	Piston 14 in. dia.	Piston 14 in. dia.	Piston 13 in. dia.	Piston 14 in. dia.
Boiler type	Belpaire	Straight top	Straight top	Straight top	Wootten con.	Straight top
Diameter	78½ in.	84 in.	84 in.	88 in.	79¼ in.	88 in.
Working pressure	205 lb.	190 lb.	190 lb.	185 lb.	200 lb.	210 lb.
Firebox, length	110¼ in.	111½ in.	120⅛ in.	108⅞ in.	126¼ in.	112 in.
Firebox, width	72 in.	70¼ in.	70¼ in.	78¼ in.	108¼ in.	96¼ in.
Tubes, diameter	5⅜ in. and 2 in.	5½ in. and 2¼ in.	5½ in. and 2¼ in.	5⅜ in. and 2 in.	5⅜ in. and 2 in.	5½ in. and 2¼ in.
Tubes, number	5⅜ in.—36 2 in.—265	5½ in.—36 2¼ in.—200	5½ in.—36 2¼ in.—200	5⅜ in.—45 2 in.—300	5⅜ in.—36 2 in.—239	5½ in.—50 2¼ in.—240
Tubes, length	15 ft. 1 in.	15 ft. 0 in.	15 ft. 0 in.	15 ft. 6 in.	13 ft. 6 in.	15 ft. 3 in.
Heating surface, firebox	175 sq. ft.	214 sq. ft.	207 sq. ft.	216 sq. ft.	225 sq. ft.	232 sq. ft.
Combustion chambers	....	....	....	....	71 sq. ft.	....
Tubes	2,841 sq. ft.	2,530 sq. ft.	2,530 sq. ft.	3,390 sq. ft.	2,359 sq. ft.	3,236 sq. ft.
Firebrick tubes	....	27 sq. ft.	....	29 sq. ft.	....	30 sq. ft.
Total	3,016 sq. ft.	2,771 sq. ft.	2,737 sq. ft.	3.643 sq. ft.	2,655 sq. ft.	3,498 sq. ft.
Superheater	623 sq. ft.	654 sq. ft.	634 sq. ft.	844 sq. ft.	575 sq. ft.	945 sq. ft.
Grate area	55 sq. ft.	54.4 sq. ft.	58.6 sq. ft.	58.7 sq. ft.	94.9 sq. ft.	74.9 sq. ft.
Driving wheels, diameter	62 in.	55 in.	54 in.	57 in.	55½ in.	61 in.
Journals	10½ in. by 13 in.	Main 11 by 13 in. Others 9½ by 13 in.	Main 11 by 13 in. Others 10½ by 13 in.	11 in. by 13 in.	11 in. by 13 in.	Main 12 by 13 in. Others 11 by 13 in.
Engine truck wheels, dia.	33 in.	30 in.	30 in.	30 in.	33 in.	33 in.
Journals	5½ in. by 10 in.	6 in. by 12 in.	6 in. by 12 in.	6½ in. by 12 in.	7 in. by 11 in.	6 in. by 12 in.
Wheel base, driving	17 ft. ½ in.	16 ft. 4 in.	15 ft. 7 in.	16 ft. 0 in.	17 ft. 0 in.	17 ft. 6 in.
Total engine	25 ft. 9½ in.	25 ft. 1 in.	24 ft. 4 in.	26 ft. 0 in.	27 ft. 0 in.	27 ft. 3 in.
Total engine and tender	62 ft. 5⅛ in.	60 ft. 1½ in.	61 ft. 4 in.	60 ft. 11½ in.	63 ft. 11 in.	74 ft. 1¼ in.
Weight, on drivers	226.900 lb.	240,320 lb.	242,300 lb.	238,000 lb.	250,800 lb.	268,200 lb.
On truck	22,600 lb.	19,940 lb.	20,050 lb.	30,000 lb.	30,300 lb.	26,700 lb.
Total engine	249,500 lb,	260,260 lb.	262,350 lb.	268,000 lb.	281,100 lb.	294,900 lb.
Total engine and tender	431,000 lb,	404,000 lb.	410,000 lb.	425,000 lb.	462,000 lb.	565,000 lb.
Tractive effort	53,300 lb.	58,700 lb.	60,600 lb.	56,000 lb.	61,500 lb.	68,200 lb.

Annual Convention of the Fuel Association

Papers on Pulverized Coal, Feed Water Heaters and Individual Fuel Performance Records

WITH an attendance of approximately 200, the International Railway Fuel Association opened its thirteenth annual convention at the Hotel Sherman, Chicago, on May 24 and adjourned after the consideration of a heavy program on May 26.

Following the usual opening exercises the meeting was addressed by Samuel O. Dunn, editor of the Railway Age. An abstract of Mr. Dunn's address follows.

Present Railway Situation

BY SAMUEL O. DUNN

Speaking of the need for economy in the use of fuel, Mr. Dunn called attention to the fact that the total cost of railway fuel in 1920 was $675,000,000, an increase of $423,000,000, or almost 170 per cent since 1916, due largely to increases in price, a large part of which took place last year. Continuing, he said:

J. B. Hurley (Wabash)
President

W. J. Bohan (Northern Pacific)
Vice-President

W. L. Robinson (B. & O.)
Vice-President

J. G. Crawford (C. B. & Q.)
Secretary-Treasurer

Since the end of 1920 there have been substantial reductions in the prices paid by the railroads for coal. It is clear, however, that further reductions must be secured in all their operating expenses, including the cost of fuel. The cost of fuel must be further reduced both by reductions in price and by the effecting of greater economies in its use. The effecting of greater economies in its use must be brought about by securing greater efficiency in the firing of locomotives and also by continuance of the installation of devices which result in less fuel being burned in proportion to the power produced.

Mr. Dunn then took up the general railway situation and briefly sketched the developments which have led up to the present condition of the railroads in the United States, most of which, in spite of the relatively high freight rates, have not been earning enough to pay their operating expenses and taxes since the new rates were fixed late in August last year. He then took up the question of reducing operating expenses, about which he spoke in part as follows:

In addition to seeking abrogation of the National Agreements, the railways have asked the Railroad Labor Board to make general reductions of wages. They base their application mainly upon the grounds that wages have been reduced in most other industries and that the cost of living has declined.

The principal answer of the labor leaders to this argument is that through mismanagement the railways are wasting about $1,000,000,000 a year, and that all this alleged waste should be eliminated before the payroll is curtailed.

After the present wages were fixed, and when the railways were still carrying a heavy traffic, their total operating expenses were running at the rate of about $6,000,000,000 a year, and of this amount almost $4,000,000,000 was going to labor in wages, leaving about $2,000,000,000 for other expenses. Since the labor leaders defend the present payroll, it follows, on their theory, that, by eliminating preventable "wastes" the managements could and should reduce all expenses except the payroll by almost 50 per cent. At least four-fifths of this other $2,000,000,000 of railway expenses consists of expenditures for fuel and for equipment and materials and supplies—iron and steel, lumber, office appliances, stationery, etc. The labor leaders claim the railways pay excessive prices for these things because the railways are under the same financial control as the concerns from which they make purchases.

It would be easy to prove, if time permitted, that all this talk about the control of railways and the concerns from which they make purchases by the same financial interests is the wildest buncombe. But suppose they are under the same control. Where is the evidence that this causes the railways to pay excessive prices for fuel and for materials and supplies? Do they pay more for coal than other large consumers? The coal operators complain loudly that the railways use the "assigned car" rule to get coal cheaper than other concerns. Do they pay more for iron and steel? Until recently they, like other consumers, were paying the United States Steel Corporation, which is supposed to be the archtype of a concern controlled by the house of Morgan, the same prices which were fixed by a government board in 1919, and which other people were paying; and they are now paying it and other steel concerns less than these prices. Do the railways pay more than others for lumber? Every lumber manufacturer and dealer will say they are close buyers. The allegation that the railways as a whole, because of their actual or alleged financial control, waste money by intentionally paying excessive prices, has never been supported by a scintilla of evidence, and it never can be, because it is absolutely baseless. .

The labor leaders also criticise the railways for not having made certain important improvements in their physical properties which would enable large economies to be effected. To make large economy-producing improvements the railways must first raise large amounts of new capital to invest in them. But they cannot raise this new capital until they are enabled to earn a net return sufficient to pay reasonable interest and dividends on their present valuation. Their net return cannot be made adequate for this purpose without large reductions of their present expenses, of which the payroll constitutes two-thirds; and the labor leaders oppose all reductions of the payroll.

I have not the slightest idea that the pre-war wages of railway employees ever will be restored, nor do I think they ever should be. There were many classes of employees who, before the war, were not paid as much as they should have been in proportion to the cost of living at that time, and I hope to see their wages in future kept higher in proportion to the cost of living than they were before. And in this connection I think special reference should be made to the cases of supervisory officers. It is a fact today, as it has been for years, that many supervisory officers are paid less than the higher paid employees over whose work they exercise supervision. Indeed, the average salary of all division officers, including superintendents, master mechanics, trainmasters, road foremen of engines, etc., is less than the average wages of some employees. According to the latest available statistics the average salary of all division officers now average $3,437 per year, while the wages of passenger locomotive engineers average $3,450 and the wages of freight engineers $3,586. The advances granted to divisional and supervisory officers since before the war have been relatively much less than those granted to most classes of employees, and as a matter of justice to the officers this fact, together with the fact that many of the officers were underpaid before, should be given great weight in any readjustments which may be made in future.

Bad as the situation is today, I am not pessimistic about the future of the railways. On the whole, I have no doubt that we have seen the worst we are going to see in the railroad business.

However, we should clearly recognize the fact that if the railroads are again to be put upon their feet the utmost efforts must be made by all of us who are directly interested in the business, first, to secure the utmost efficiency and economy of operation, and, second, to keep the public fully informed regarding everything that is being done to promote efficiency and economy, in order that the many unjust attacks which will continue to be made upon the managements of the railroads in the future, as they have been in the past, will not mislead public opinion regarding private management. All of us who are in close touch with railway affairs know that private management is by no means perfect, but we all have very good reason for believing it is much better than government management or Plumb plan management would be, and, therefore, it is our duty to do all we can to make sure that private management will be perpetuated.

President Hurley's Address

Following Mr. Dunn's address, J. B. Hurley delivered the presidential address, of which an abstract follows:

The occasion that bids us gather in convention at this time is indeed an important and impressive one. Many great and perplexing questions confront the mind of America today and call for settlement—never probably in the history of the nation was there a time when loyal citizenship and patriotic co-operation on the part of all for the good of her institutions, for the maintenance of her business enterprises and for a respectable moral standard was more desired than at present. War with its horrors and sacrifices brought extravagance. The emergencies of the times to a great extent broke down our systems of economy and an extravagant increase in material, in production, in labor was a natural outcome of urgent necessity.

The war has ended, but it has left its impressions and its deadly influence—excessive profits and wages of war times have brought a spirit of unrest and discontent to the minds of those who in their loyalty are asked to practice economy that our business interests may prosper, that we may take our place even with keen competition, not only as the first nation of the world by our wealth, but first as an industrial and commercial nation. This is the prime object of our convention—that we may bring about a better feeling and spirit between employer and employee, that we may win the employee by interesting him in his work and making him feel that work is rather a pleasure than a crime—that we may better the employee by educating him to know and understand his work that he may do it well, and hence, be a source of satisfaction and interest to his employer, that by so working, the employer may know and understand that the work of the employee is of first interest to the employer and that he concern himself in working for and bettering the working and home comforts of his employees when consistent. A spirit of mutual interest between employer and employee is an absolute necessity if our business is to prosper and grow.

Report of Committee on Pulverized Fuel

The progress of the art of burning pulverized coal by railroads on locomotives or in stationary plants the past year has, on account of well understood economic and other conditions, been practically nil, no new installations having been made.

Some few tests have been made. One of these which is of some interest was made on Lehigh Valley locomotive No. 1360 between Easton and Lehighton, Pa., to determine the practicability of burning pulverized North Dakota lignite containing 15 per cent moisture and Red Lodge sludge (Montana sub-bituminous coal) without resulting in serious honeycomb formation or unusual disintegration of brick work.

The results were successful with the exception of the honeycomb formation which with either coal developed rapidly on the back flue sheet when the locomotive was worked hard and seriously hampered operation. The committee suggests that this honeycomb formation be not taken too seriously and believes that with proper research and engineering work to determine the coal characteristics and to develop proper design of boiler and firebox with particular reference to combustion area and also to drafting, that this problem can be solved. In connection with drafting the committee has in mind the elimination of pulsating draft and correctly determined air supply.

In stationary practice two new cases of pulverized coal operation have been called to the committee's attention. The Milwaukee Electric Railway & Light Company during the past year completed and put into operation a new power plant at St. Francis, near Milwaukee, Wisconsin, manifesting their confidence in the economic advantages of burning pulverized coal.

The Oklahoma City plant of Morris & Company, originally equipped with chain grates, has been modified to burn either pulverized coal or oil and has been in successful operation for a little over a year. By the use of suitable burners it is practicable to burn either pulverized coal or oil without changing furnace or boiler. The coals used are McAlester Field having a B. t. u. value of 10,000 to 11,500; moisture, 5 to 10 per cent; volatile matter, 20 to 30 per cent; fixed carbon, 40 to 45 per cent; ash, 30 to 35 per cent; sulphur, 1 to 2 per cent, and Texas lignite having a B. t. u. value of 6,000 to 7,000; moisture, 30 to 35 per cent; volatile matter, 20 to 25 per cent; fixed carbon, 25 to 30 per cent; ash, 10 per cent.

This plant is reported as being particularly economical in cost of operation, showing an 8 to 10 per cent saving in cost of steam production on McAlester coal, over the stoker fired boilers burning coals of equivalent B. t. u. values. Accurate daily records of cost are maintained for comparison.

The state of the art today indicates an unquestionable field for pulverized coal and that its commercial use depends upon the economic conditions obtaining, each case requiring its own particular analysis.

The committee repeats its previous recommendation that thorough research and engineering work accompanied by conclusive tests be conducted at one of our universities adequately equipped, particularly for burning of pulverized coal on locomotives, the work to be supervised by competent men representing the railroads and the university.

The report is signed by W. J. Bohan (Nor.-Pac.), chairman; H. T. Bentley (C. & N. W.); R. R. Hibben (M. K. & T.); H. Piollet (Lehigh Valley); W. G. Squires (N. Y., N. H. & H.); J. M. Nicholson (A., T. & S. F.); L. R. Pyle (Locomotive Firebox Co.); W. L. Robinson (B. & O.), and E. C. Schmidt (North American Co.).

Discussion

Alonzo G. Kinyon (Fuller Engineering Company) expressed the opinion that it would not be many years before as high as 50 per cent of the coal burned would be in a pulverized form, this statement applying particularly to industrial and power plants. He said that the locomotive, as at present designed, was not well adapted to burn pulverized coal under all of the conditions it is called on to meet. Thus far nothing has been developed which will eliminate trouble from honeycombing, with certain coals when the locomotive is working at high capacity.

Eugene McAuliffe said that it is yet to be proved whether a kilowatt-hour is produced with fewer heat units from pulverized coal than from coal burned on grates, but laid stress on the versatility of pulverized fuel burning equipment where relative values of oil and coal call for frequent changes from one to the other.

Locomotive Feed Water Heating

The interest in feed water heaters in America is shown by the history of the past year to be growing, in that the number of roads to take up types of feed water heaters for tests has increased. There are no new feed water heaters brought out this year, but progress has been made in the simplification of the design of the Locomotive Feed Water Heater Company and Worthington systems.

In 1920 there were seven roads using the Locomotive Feed Water Heater Company, Weir, Worthington, Caille, and the Simplex Blake-Knowles feed water heaters. There are now eighteen American roads with five types of heaters on order or in service; namely, the Locomotive Feed Water Heater Company, Weir, Worthington, Caille, and the Simplex Blake-Knowles. These are as follows:

The Superheater Company's Feed Water Heater:	
Delaware & Hudson	2
New York Central	4
Delaware, Lackawanna & Western	1
Ft. Smith & Western	2
Grand Trunk	1
Erie Railroad	5
Canadian Pacific	1
New York, New Haven & Hartford	5
Atchison, Topeka & Santa Fe	2
Southern Pacific	4
Central Railroad, New Jersey	1
Central Vermont	2
Chicago & North Western	2
Lake Shore & Michigan Southern	1
Elgin, Joliet & Eastern	2
Total on order and applied	35
Worthington Feed Water Heater:	
Pennsylvania Railroad	4
Norfolk & Western	1
Southern Pacific	5
Chicago & North Western	2
Total on order and applied	12
Weir Feed Water Heater:	
Canadian Pacific	1
Southern Railway	2
Grand Trunk	1
Total on order and applied	4
Caille Feed Water Heater:	
Baltimore & Ohio	1
Simplex Blake-Knowles Feed Water Heater:	
Erie Railroad	3

The Southern Pacific is trying out some of both the open and closed types of heaters. The roads which have tested out these heaters are securing practically the same results as given in the results of tests of the two classes of heaters, a saving of between 13 and 15 per cent based on increase in evaporation of pounds of water per pound of oil. However, in bad water districts it has been found necessary to clean the closed heaters due to scaling, in order that this saving be maintained. No data are available in bad water districts of the Worthington heater. Several means have been tried for the cleaning of the closed type of heaters, and it is believed that satisfactory means at low cost have been secured using a dilute solution of hydrochloric acid, but service alone can determine the life of the feed water heaters and flues.

The question of weight on drivers has to a certain extent influenced the adoption of the feed water heaters as at the present time the railroads have this problem to contend with, and in order to keep the weights of the locomotives within the bounds prescribed by their various roads, this valuable method of saving fuel has not been universally adopted.

The report is signed by E. E. Chapman (A. T. & S. F.), chairman; E. A. Averill (The Superheater Co.); O. S. Beyer, Jr.; B. J. Farr (Gd. Tk. Wn.); F. Kerby (B. & O.); A. T. Pfeiffer (N. Y. C.); L. G. Plant (Ry. Review); L. R. Pyle (Locomotive Firebox Co.), and W. H. Winterrowd (Can. Pac.).

Discussion

Eugene McAuliffe expressed the opinion that feed water heating had proved an effective means of reducing fuel consumption and the application of such devices is now only a question of obtaining the necessary capital.

J. N. Clark (Southern Pacific) described the results of feed water heater tests which showed that in some cases the heaters raised the temperature of the water up to 255 deg. F. He stated that the maintenance of the heater needs to be carefully considered, especially in bad water districts where it requires frequent cleaning because the savings largely disappear when scale forms on the surfaces.

E. E. Chapman stated that the saving in various tests range from 8.4 to 16.6 per cent. He pointed out that feed water heaters reduce the rate of combustion and thus lengthen the life of boiler tubes and firebox sheets. It has been found advisable on the Santa Fe to clean the heaters every two weeks with a diluted solution of muriatic acid. This operation requires about two hours and is effective in removing scale.

Standards of Fuel Economy

D. C. Buell, director, Railway Educational Bureau, presented a paper on this subject, in which he gave a comprehensive outline of the steps which must be taken before ideal results can be secured in any campaign for the economical use of railway fuel.

Starting with the executive, Mr. Buell took up the essential requirements of a fuel conservation policy, and outlined the matters for executive attention in the purchasing, operating and mechanical departments. The conditions which require the attention of the supervisory forces were then enumerated for all departments concerned, including fuel inspection, operating requirements, the important points for attention in the shops and roundhouse and the points requiring special attention by the road foreman.

Referring to the 78 points enumerated, he said in closing: "There is hardly an item in this entire list which has not been a subject for a paper or for discussion at some of the conventions of the International Railway Fuel Association. Those who have been members of this Association for a number of years have their file copies of proceedings which can be referred to in order to check the methods presented to this Association by practical fuel men, which have proven successful in dealing with these numerous problems.

"Those who have only recently become members of the Association can obtain back copies of the proceedings of the last few years from the secretary for a nominal sum.

"The problem of fuel economy is just as much a science as any other of the engineering problems, and it is only through a careful study and analysis of individual problems that an officer whose duties involve a responsibility for fuel economy may hope to obtain satisfactory results. Therefore it is urged upon the members of this Association that our proceedings be used as a reference library to be referred to and studied, in order that they may become more proficient in this branch of our American transportation problem.

Discussion

Harrington Emmerson briefly sketched the history of the development of the use of steam power from the first crude steam engine when there was no quantitative measure of the energy in the coal at one end or of the work performed at the other, through the steps that finally led to the present knowledge of steam engineering which makes possible a definite determination of the efficiency of the application of fuel to the production of work. He concluded that what was necessary in the efforts of the railways in fuel conservation were similarly definite standards of fuel consumption in relation to ton-mile output so that the success of fuel economy programs could be definitely measured.

In closing the discussion Mr. Buell stated that in developing and correlating the various factors in a complete plan for fuel economy, he had followed the principle of dependent sequences developed by Harrington Emmerson in his paper presented before the association at the 1915 convention. Mr. Buell also acknowledged the importance of definite standards under present conditions, since the public has a right to inquire as to the efficiency with which the railroads are managed and operated and the railroads cannot afford to be without some such standards, the absence of which will indicate to the public a lack of knowledge of the fundamentals of their own business.

Value of Individual Fuel Performance Records

BY ROBERT COLLETT
Superintendent Fuel and Locomotive Performance,
New York Central

There have been presented before this Association several papers outlining the practice on various railroads where individual fuel records have proved valuable and which in some instances continue in force. A reasonably thorough canvass, however, discloses that such records are by no means standard practice on American railroads, chiefly, it seems, for the reason that the general method of determining individual coal charges to locomotives is largely guesswork. The value of any record lies in what we get from it and depends on the good or bad opinion of those who live with it. Mr. McAuliffe once aptly said: "I have been connected with a dozen different kinds of fuel performance records not one of which was absolutely correct, but the worst was better than none at all."

Railroad officers fully appreciate the need of knowing, first, about how much fuel is required for a given service, and secondly, how much is being used. How best to get this information depends chiefly on local conditions. With present day facilities on the average railroad it is not possible to present to an engineman or fireman a bill, so to speak, for a certain amount of fuel burned for which he is responsible, since all of the old handicaps of delays, light mileage, etc., over which he has no control, are still with us and added thereto are complications such as changing firemen, pooled engines, no means of measuring coal, and so on.

The engine record seems the best as a rule, save for oil-burners under certain favorable operating conditions, and this plan now predominates. The average cost of compiling such a record proves to be from one-half to one cent per ton of coal used. It is not usually intended as a check against the total fuel consumed, but to keep interest aroused. Grouping selected runs and showing only representative trips and not necessarily the total mileage or total fuel consumption for the month, has met with success on certain roads. The value of a fuel record also depends on how it is handled with the engine crews and departments responsible.

There are individual records which may be of value, although not elaborate. On the New York Central Lines East, we have made a great many trip records of fuel consumption and given considerable publicity on the road to these reports in an effort to apprise all concerned of what is considered good performance. Also, through various records of observations we attempt to check conditions affecting fuel costs, which include locomotive operation, quality and distribution of fuel, locomotive conditions, transportation matters, and lubrication. One reason for including the latter is the claim so often made that oil is often saved at the expense of fuel. These individual observations are made in company with a division officer and matters are handled on the ground, in preference to writing letters. The idea is not so much to improve the individual waste as to have conditions right on the division and the railroad as a whole.

We give each division officer, including traveling firemen, what we call a bill of expense each month for the fuel burned in each class of service, the unit consumption, and the total cost. We also show this in "Cost per 1,000 Locomotive Miles." One reason for this is to compare the relative cost of fuel with other items which may have received no more attention than they deserved, but relatively far more attention than the fuel costs. On the enginemen's bulletin boards we post a statement of miles run per ton of coal in each class of service, with a foot-note showing the number of scoops used per mile and what a small saving would amount to. We find the men like this even better than the gross ton-mile statements, although we post them also. Recently, we have been posting at some of our terminals the coal charges as shown by our daily report of disbursements, which shows the engine number, to which we have added the train number. Of course, it gives the crews an opportunity to criticise our coal estimates, but it creates interest and makes us careful in our estimating.

If we get individual effort collectively applied and concentrated on ways and means to encourage pride in having our railroad the best in fuel performance, it matters not so much what kind of records we have. If our records give individuals credit and commendation where due, and point out to all departments and individuals in a co-operative spirit what we are doing, what it is possible to do and in some small way at least how to do it, we will have two fuel supervisors on every engine and one in every office.

I believe in an individual record and a daily check of the coal burned, so far as practicable, against the ton miles or passenger car miles for the education and interest it affords to those who follow fuel economy and who use fuel. But no record ever taught a man how to fire or run an engine more skilfully than he already knew. We certainly need and in time will have better and more fuel records on American railroads, but where successful, under present coaling arrangements, they will not attempt to stress individual liability so much as they will the possibilities of concerted effort.

Discussion

J. G. Crawford (C. B. & Q.), presented a written discussion from which the following is taken:

In 1917 a committee consisting of an assistant auditor, fuel distributor, inspector of stores, traveling accountant, engineer of tests and myself were appointed to investigate fuel accounting. The accounting necessary in connection with the "Daily and Monthly Enginemen's Fuel Performance Statements" influenced the fuel accounting to a considerable degree, and the first work of this committee was to find out what use was made of them and to estimate their value.

The committee assumed that the reports were for the following purposes:

(1) To create interest among enginemen which would result in a more economical use of locomotive fuel.

(2) To give master mechanics and road foremen a statement which they can use to determine the relative standing of the enginemen so that they can urge, require and demand improvement of those whose performance is below what it should be.

(3) To give superintendents of motive power and other general officers a summary of the effects of fuel economy efforts.

Twelve division points and two important terminals were visited. Master mechanics, road foremen, engineers and firemen were interviewed. Bulletin boards and bulletin books were examined to ascertain the manner and date of posting these statements. About one-half of the eighteen divisions were found to be making out the daily statement.

All divisions compiled the monthly statement. This could not be avoided, because the monthly statements from each division were consolidated into a system statement. Of the twelve division points visited only eight had the monthly reports posted. Some of these had not been sent to roundhouses for posting for over a year and one was being put in the waste basket by the roundhouse clerk. Only five division points had made out and posted the daily reports. One division did not figure the pounds of coal per switch hour, per passenger car mile or pounds per hundred ton miles or the average speed. In some cases the daily reports were carbon copies, made with pencil instead of typewriter, and were not readable.

The daily reports were posted too late to be of any value. It was originally intended to post these within 48 hours after the day covered by the report. The monthly reports were posted about three weeks after the end of the month. At one point where there are ten bulletin files the four last monthly reports were on three different files.

Of 122 engineers and firemen interviewed, 51 stated they did not examine the statements and 66 said they did occasionally, but they could not tell their approximate standing.

Of nine master mechanics interviewed eight did not use the reports and recommended discontinuance, one said it was one of the most important reports.

Eight road foremen were interviewed, of whom six did not use the reports and recommended their discontinuance, while one used and recommended discontinuance, and one used and made no recommendation as to discontinuance.

These reports were discontinued.

On any railroad there are a large number of engineers who are as conscientious and as capable as the officials who supervise them. This class does not need much supervision and an inaccurate individual fuel performance record is of no value in bringing about greater fuel economy in their case. There is a second group of men who are as conscientious, but not as capable and could be appealed to through an accurate statement, but not through one which is inaccurate. The third class as I see it is not conscientious; is subdivided between both capable and incapable. This class, though small in number, requires an excessive percentage of the road firemen's time. Something could be done with this group if an accurate individual fuel performance record were available, but an inaccurate record is of no value.

It seems to me that the smallest unit on which to base a fuel performance record, is the division until such time as an accurate record of the coal used by each engineman is obtainable. The statement using the individual engine as the unit is slightly more accurate than the statement using the engineer or the fireman as the unit, as there are a lesser number of engines than engineers or firemen. However, the principal advantage of making an individual engine fuel performance record in place of an individual engineman's fuel performance record is that the engines cannot talk back and tell you how inaccurate is the statement.

Nothing herein should be construed as not advocating working on the individual engineer and individual fireman to obtain the greatest fuel economy, but working through the medium of an inaccurate individual engineman's performance record is not advocated and should be discouraged.

Other Papers

A number of other papers and reports were also presented, including committee reports on the Storage of Coal, Fuel Accounting, and Firing Practice. The individual papers included Fuel Conditions on French Railways, by M. de Boysson, chief of locomotive service, Paris-Orleans Railway; Fuel Economy—A Few Essentials, by Carl Eduard Uddenberg (State Railways of Sweden); Preparation and Distribution of Fuel, by C. E. Bast, fuel engineer, Delaware & Hudson; Fuel Department Organization, by L. G. Plant, (Railway Review); Oil Shale as a Source of Oil Supply, by Martin J. Gavin (Bureau of Mines); Cost of Production of Coal, by Mont B. Morrow (Canmore Coal Company, Ltd.); and Report on Briquettes and Sub-Normal Fuels, E. E. Ramey (B. & O.), chairman.

Other Business

Eugene McAuliffe (Union Colliery Company) in an address before the association, called attention to the lack of co-ordination between the carriers and the coal industry, although the movement of coal constitutes approximately 37 per cent of the gross ton-miles of freight movement and the railroads purchase from 25 per cent to 28 per cent of the bituminous coal production. He advocated the establishment of seasonal freight rates on coal as a means of effecting a better local factor on both the mines and the railroads.

One of the features of the meeting which received favorable comment on several occasions was the presence of eight engine crews, one from each division of the Atlantic System of the Southern Pacific. These men, who had had the best fuel records on their respective divisions during the previous three months, were sent to the convention by the management as a mark of recognition for the results they have obtained in their efforts to save fuel. This is a part of the newly developed plan of division fuel committee organization on the Southern Pacific System.

During the convention Harrington Emmerson distributed to the members copies of a summary of the Interstate Commerce Commission railway fuel report for 1920 which he had prepared showing the costs of the various kinds of fuel on an equated heat unit basis.

On recommendation of the Committee on Constitution and By-Laws, the annual dues of the association were raised $1 a year.

The following officers were elected for the coming year: President, W. L. Robinson (B. & O.); vice-presidents, J. N. Clark (Southern Pacific), M. A. Daly (Northern Pacific), and W. J. Bohan (Northern Pacific); members of the Executive Committee: H. T. Bentley (C. & N. W.), D. I. Bergin (Wabash), C. M. Butler (A. C. L.), J. W. Dodge (Illinois Central), Joseph Keller (Lehigh Valley), and Hugh McVeagh (Big Four).

Chicago was chosen as the place for the next convention.

The 100-Car Demonstration Train Rounding a Curve on the New River

Virginian Demonstration of Double-Capacity Brake

Train of 16,000 Tons Handled Down 1.5 Per Cent Grade; Close Speed Regulation—Low Air Consumption

ALL records for the operation of a heavy train down a long grade were shattered on May 25, when there was handled from Princeton, W. Va., eastward to Roanoke, Va., on the Third district of the Virginian Railway, a train of 100 loaded 120-ton cars of coal aggregating 16,000 gross tons. This train was a test train run to demonstrate what could be done with the new 120-ton cars and the double capacity brakes used by the Virginian Railway. It marks the latest step in the progress towards heavier train loading which has characterized the operations of the Virginian since its inception.

The Virginian Railway's theory of operation is stated in the following words: "The more loads you haul in one trip the less trips you'll have to make." The road was built with that idea in mind. Today the company is operating with the largest capacity equipment and most powerful locomotives which are in service in this country and therefore in the world. The success the road has been having in working out its scheme of operation is attested by the fact that the road is hauling in regular service trains of 90 to 100 loaded cars aggregating 8,000 to 9,000 gross tons. The average net tons per train—the figure which includes all freight trains of whatever kind—in 1920, totaled 1,800, the largest for any road in the country.

Westinghouse Double Capacity Brake

The double capacity brakes as applied on the Virginian 120-ton cars represent the latest development of the Westinghouse Air Brake Company's equipment for long trains of extremely heavy cars. Some time previous to the introduction of the 120-ton car, the road had consulted the air brake company with regard to handling still greater tonnage by operating 90 or more 55-ton cars per train. This brought up the question of applying a special brake with a double capacity feature, the KCE 10-10, which had already been developed in anticipation of a demand for heavy-tonnage operation that would necessitate the use of a brake providing a more uniform breaking ratio, lighter retardation on empty cars with a substantial reserve braking force available in the case of loaded cars.

Eleven hundred of the 55-ton cars of the type then in use were equipped accordingly with the double capacity feature. The results were so gratifying that the Virginian saw the possibility of extending the use of such apparatus to cover the requirements of much heavier rolling stock.

It was early developed that to secure the required results, it was necessary to put in a train cars with the empty and load brake to the amount of 15 per cent of the total train—in other words, 15 cars in a total of 100. At first it was thought necessary to keep the empty and load brake cars at the front of the train. This was later found to be unnecessary, so they are now distributed throughout the train as they happen to come, the only requirement being to get the 15 per cent empty and load brake cars.

During the spring and summer of 1914, the advisability of increasing the capacity of the individual car was suggested with the object of not only increasing the tonnage of the train, but at the same time decreasing its length. This suggestion resolved itself into the 120-ton capacity car. The Virginian ordered the construction of the cars on the assurance of the Westinghouse engineers that the first double capacity brake had been further developed to a point that would meet the requirements of the heaviest car that any railroad could conveniently handle from the standpoint of motive power.

The problem of providing the proper brake equipment for these record-breaking cars was solved by minor modifications in the double capacity equipment, which had already been brought to a high degree of development in anticipation of a demand for freight brakes of exceptionally high capacity. It is significant of the well-rounded development of the air brake art that the conditions to be met on the Virginian involved only one new factor, the high ratio of loaded weight to the light weight of the car. The grades presented no special difficulty since trains are being handled daily with air brakes alone on much steeper gradients. The length of the train was no greater than has been successfully handled with the existing equipment and the total weight of the train is of secondary importance since each additional unit increases the braking force correspondingly.

The principal problem in braking these heavy cars, as already stated, was to provide a suitable ratio of braking force to car weight, both loaded and empty. The equipment as finally applied and demonstrated between Princeton and Roanoke is known as Schedule KDE-4-10-16, indicating that three cylinders, whose diameters are represented by the figures, are employed. A change-over valve and a load reservoir are used to provide the flexibility in braking force which makes it possible to obtain a uniform braking ratio in solid trains of loads, solid trains of empties, or mixed trains. The cylinders in load operation augment each other in such sequence that only a short piston travel is required in each case, making for practically normal air consumption, though providing a much greater braking force than is obtainable with the standard single capacity brake. The relative braking force and air consumption of the double capacity brake and various types of single capacity equipment are clearly shown in one of the diagrams.

Operation of the Brake

The fundamental characteristic of the double capacity freight brake equipment is that it provides for the same percentage of braking force (ratio of total shoe pressure to car weight), on a loaded car as on an empty car.

With the single capacity brake the braking force developed is constant in magnitude but varying in its relation to the car weight. Consequently, it is much less effective on a loaded car than on an empty car. The usual practice has been to so design the brake layout as to provide the highest practicable percentage of baking force on the empty car, 60 per cent being the standard for freight cars, and then to accept whatever reduced braking ratio might be available for the loaded car. This means that in grade service the retarding force on a loaded train may not be adequate for safe control, and in level road service the retarding force may vary so much throughout a mixed train as to be productive of damaging shocks. Furthermore, in long trains of empties, severe shocks are often created because of the high braking ratio, which manifestly cannot be lowered if any appreciable braking force is to be realized on a loaded car, and also because of the inherent serial action of a purely pneumatic brake.

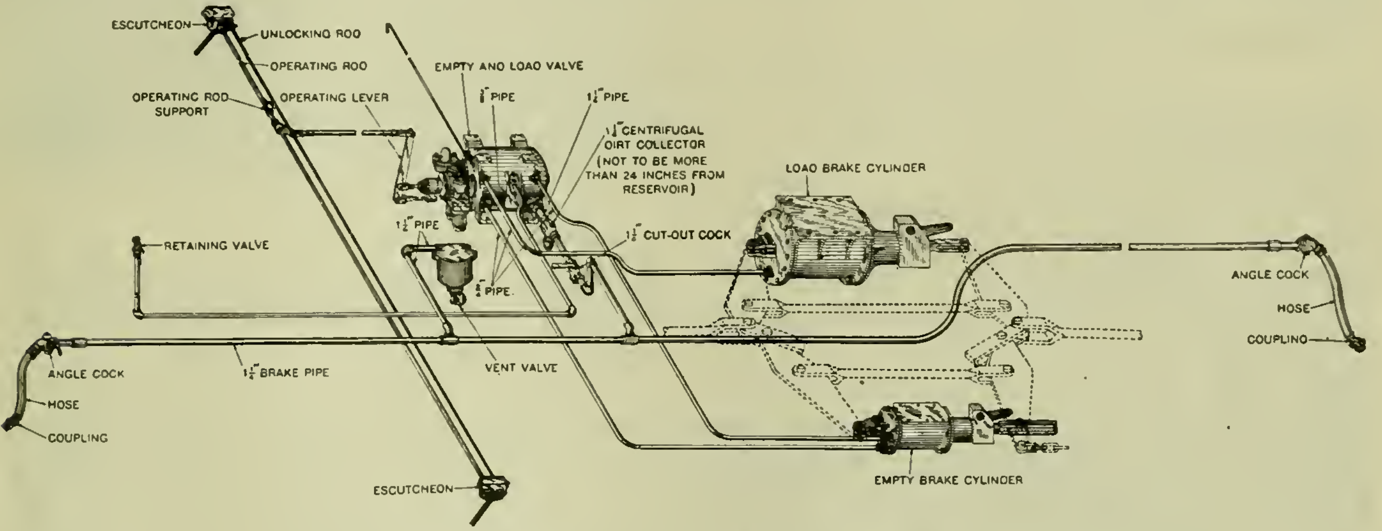
In the effort to mitigate these undesirable effects, various expedients are sometimes resorted to which are far from satisfactory, and restrictions are often imposed on train make-up and operation which tend to curtail traffic.

Obviously the ideal condition is that in which the braking force on loaded cars bears the same relation to the loaded weight as that on the empty car bears to the light weight, so that adequate and uniform retardation may be possible.

The ideal condition, always desirable, becomes imperative with heavy tonnage trains made up of high capacity cars, because of the great difference between the loaded and empty car weights. In other words, the operating conditions of loaded and empty trains with modern equipment are so widely separated that any attempt at a compromise between the two will result in unsatisfactory operation with either one or the other. The degree of retarding force set up on an empty car must be such as to permit a train of empties to be handled without the possibility of unduly severe shocks. On the other hand, with a loaded car a degree of retarding force must be provided which will be adequate to control safely a loaded train down a grade. These two requirements are so far apart that a solution of the problem is possible only with a *double capacity brake,* one which will be equally as effective when the car is loaded as when it is empty.

With the double capacity brake equipment the brake layout is designed to provide for 40 per cent braking ratio as against the usual 60 per cent for an empty car (permitting smoother brake operation on long trains of empty cars), and also 40 per cent for the loaded car as against the usual average of 15 per cent.

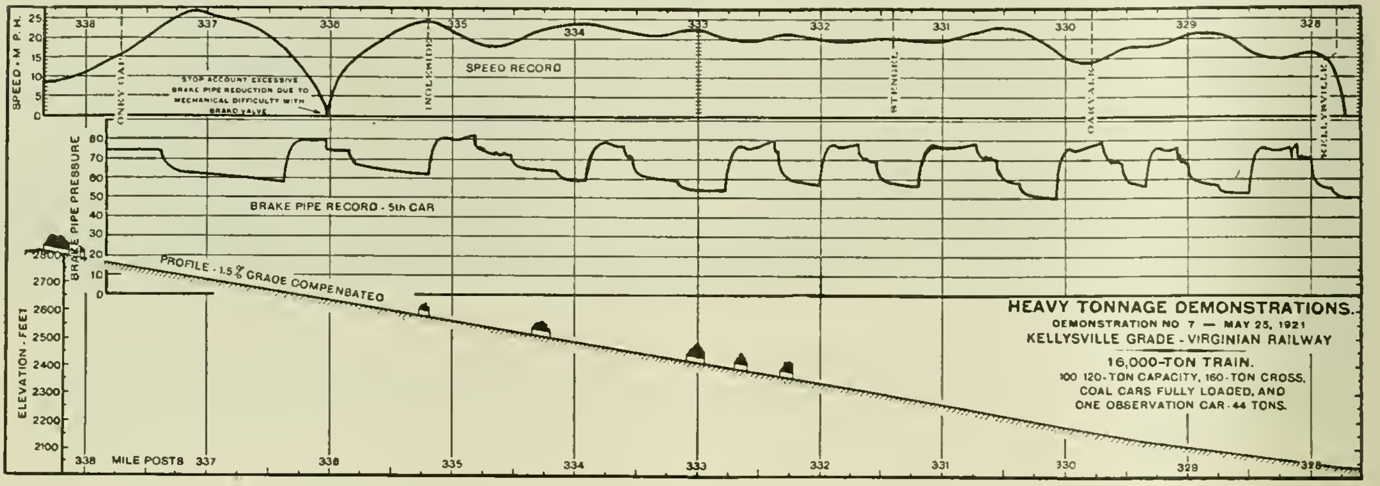
The equipment, known as schedule KDE-4-10-16, has three brake cylinders of the size indicated by the numerals. They are the take-up cylinder, the empty cylinder and the load cylinder respectively. In addition to the usual auxiliary reservoir there is a small load reservoir provided to supply the additional air required for loaded car braking.



General Arrangement of Double Capacity Brake Equipment on the Car

When the equipment is set for empty car operation, the take-up and empty cylinders, which are built into one structure with the small piston operating within the larger, operate as one 10-in. cylinder similar to the standard single capacity brake. When the equipment is set for loaded car operation the take-up cylinder piston first takes up the slack in the rigging and brings the shoes firmly against the wheels. Then the empty cylinder piston moves out a slight amount, its clutch gripping the notched push rod of the take-up cylinder piston, thus supplying additional force. Finally, as the brake pipe reduction continues, the load cylinder piston moves out a slight amount, gripping its notched push rod and adding to the force already developed, through the connecting rods and levers. By this method of slack take-up and short travel of the larger pistons the volume of air required for a given application is reduced to a minimum. In addition, especially where retaining valves are used, after the first reduction required to bring the load cylinder into operation (about 12 lb.), all succeeding reductions are much lighter, and consequently the air consumption is more economical than with any other form of equipment for a corresponding degree of train control, and still within the capacity of the standard 1¼ in. brake pipe—an important requirement.

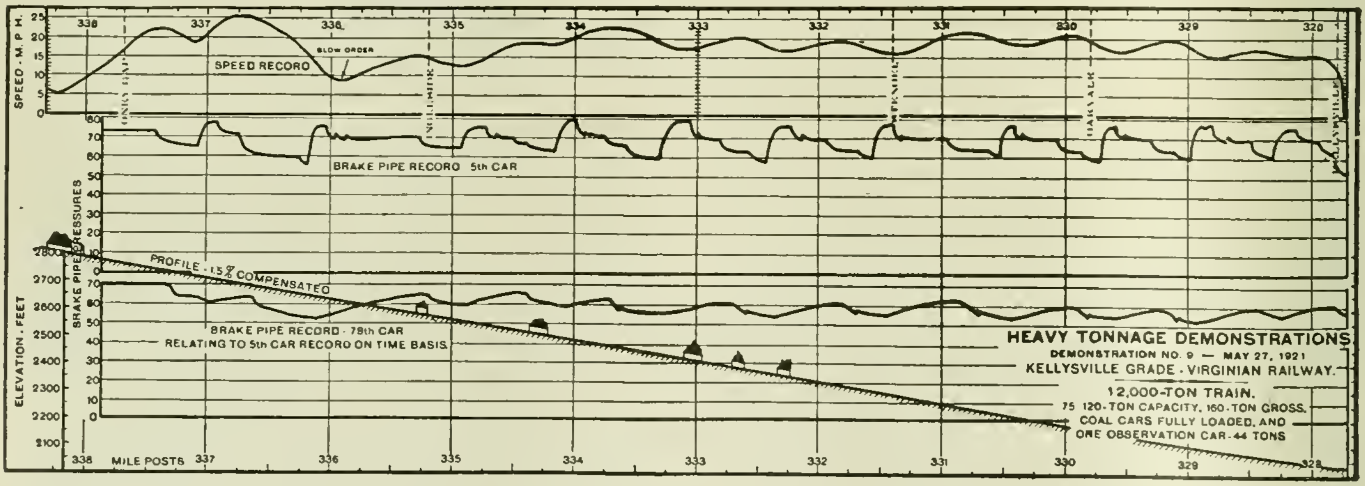
The higher braking ratio necessary for the loaded car can only be obtained when desired, since the equipment is manually changed for loaded car braking, through the medium of an operating mechanism which shifts a change-over valve to its load position. This valve functions similarly to a number of cut-out cocks to effect the proper volume and port arrangements, and also controls the flow of air to the cylinders in the proper sequence.



Speed and Brake Pipe Pressures on Kellysville Grade, 100-Car Train

The equipment may be manually cut into empty position again, or if this is not done, it will automatically return to empty position when the pressure in the system leaks down to about 15 lb., as would be the case, for example, when the car is being unloaded on a siding.

The triple valve used with this equipment (designated the K-E-N), possesses the same essential characteristics of quick service, uniform recharge and uniform release as are embodied in the well known K type of valve now in general service. A separate quick action device in the form of a brake pipe vent valve is employed.



Speed and Brake Pipe Pressures on Kellysville Grade, 75-Car Train

Attention should be called to the fact that the unit system, fundamental to all brake equipment now in use on freight cars, is preserved with this new equipment, so that if there be excessive brake cylinder leakage on one car it affects that car only and does not interfere with the proper operation of the remaining brakes in the train. This feature insures the desired flexibility and safety of brake control.

Handling a 16,000-Ton Train Down 1.5 Per Cent Grade

The impressive run—the peak of heavy train operation on any railroad—which was made on the Third district of the Virginian on May 25, presumably sets a record in heavy train loading which will not be again reached for some time. On that day a train of 100 of the new 120-ton gondola cars, each loaded to its full capacity, making an aggregate train load of approximately 16,000 gross tons, was successfully handled both on the heavy grades and on the comparatively level sections between Princeton and Roanoke. This train was handled with one of the Virginian, Class 800, AE 2-10-10-2 Mallet locomotives at the head end.

The AE Mallets are the largest locomotives in service on any railroad. They have a total weight in working order, including engine and tender, of 898,300 lb. Working simple, they have a tractive effort of 176,000 lb. and compound, 147,200 lb. The Virginian owns 10 of them.

The distance from Princeton to Roanoke is 97.2 miles. Train operation over this district is down a descending grade beginning a short distance out of Princeton and extending to Kellysville, 12 miles east of Princeton, the grade being of 1.5 per cent. The successful operation of the train down this grade was the real test which the train had to meet. From Rich Creek east of Kellysville there is an ascending grade of 0.2 per cent which presents no particular difficulty. Between Whitethorne and Merrimac an ascending grade of 0.6 per cent is encountered and in regular operation, as in the case of the test train, pushers are used. Beyond Merrimac, there is a short descending grade of 1.5 per cent, followed by descending grades of 0.9 per cent and of 0.6 per cent into Roanoke.

Test Demonstrates Train Load Limit Not Reached

The project of handling this long and heavy train over this particular district was undertaken with the idea of demonstrating that the limit for train loading has not yet been reached and also to observe, in actual service, the new Westinghouse double-capacity brake with which the cars are equipped. During the run to Roanoke, records of the brake performance were made by means of recording instruments on the locomotive, on the fifth car and on an observation car at the rear end of the train. The speed of the train was also shown by speed indicators installed in the observation car.

Train Ready for Standing Tests

To start the loaded train at Princeton, three eight-wheel switching locomotives were used as pushers, these being dropped when the train had reached a speed of 12 miles an hour. A 2-8-8-2 Mallet pusher was also used from Rich Creek to Merrimac, over the 0.2 per cent grade to Whitethorne and thence up the 0.6 per cent grade from Whitethorne to Merrimac. The start at Princeton was made smoothly. The run down the 1.5 per cent grade from Princeton to Kellysville was made at a speed of 20 to 27 miles an hour under control at all times. Due to the long and heavy train it was necessary to put a pusher on at Rich Creek instead of at Whitethorne as is done in normal operation. The pusher was dropped at Merrimac. From Merrimac to Fagg down the short stretch of descending 1.5 per cent grade, the train was handled at a speed of from 20 to 30 miles an hour, and from there on to Kumis and Roanoke at 15 to 20 miles an hour. During the trip the train had two break-in-twos due to defective knuckles and to the fact that the engineman was not familiar with so heavy a train.

Standing Tests

Before starting on the run to Roanoke a thorough inspection of the train was made and every precaution taken to have the cars and brakes in good condition. In order to insure proper action of the brakes, and also to demonstrate the special features of the empty and load brake to the railroad men and other engineers and observers who were present, a number of standing tests were made in the yard at Princeton. For the purpose of making these standing tests, the train was parted at the middle, the two parts placed on adjacent tracks, and the brake line connected up so that the front and rear ends were brought near together where both the start and finish of the brake action might be observed. These tests included an emergency serial action of the brake which was completed in 7.5 seconds; a quick service serial action in 13.9 seconds; and an emergency action in 8 seconds after the completion of a heavy service application. The value of such a brake performance, particularly in the severe service on the Virginian, will at once be apparent to men familiar with train operation. Demonstrations were also made of the operation of the take-up cylinders; the operation of the brake under both empty and load conditions; and the automatic return from load to empty position.

As the cars were assembled for the standing tests the train brake pipe, exclusive of the branch pipe and locomotive and tender, measured 4,097 ft. on the 70 car train, and 5,837 ft. when the additional 30 cars were later cut in.

No. 1—10-Pound Service Application—Brakes in Empty Position

The time from brake valve movement to piston start on Car 70 was 13.9 sec.; the rate of quick service propagation, 294 ft. per sec., or 201 m.p.h. The resultant cylinder pressure on Car 1 was 35 lb. and on Car 70, 25 lb. The time from movement of the brake valve to full release position to start of release on Car 70 was 10.5 sec.

No. 2—Emergency—Application—Empty Position

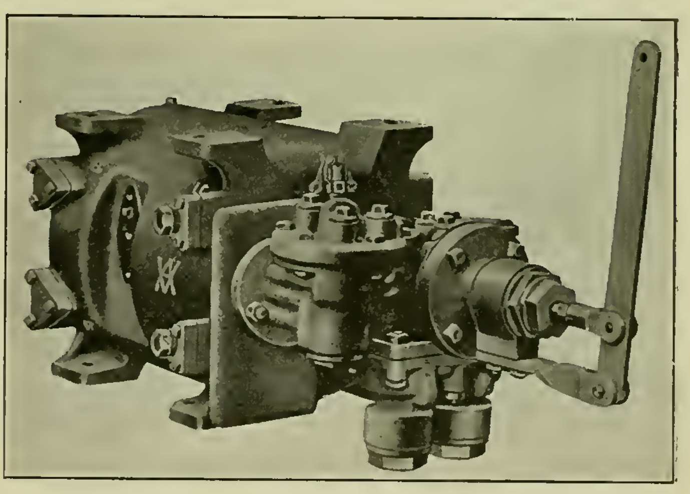
Time from movement of brake valve to emergency position to piston start on Car 70, 7.5 sec.; rate of emergency propagation, 546 ft. per sec., or 372 m.p.h. The resultant cylinder pressure on Car 1 was 54 lb., on Car 70, 51 lb.

No. 3—Emergency After Service Application—Empty Position

Service pressure in pounds, Car 1, 36; Car 70, 19. Service time in seconds, 13.8. Emergency pressure in pounds, Car 1, 53; Car 70, 50—time, brake valve to Car 70, 8 sec.

No. 4—To Illustrate the Double Capacity and Air Economizing Features

It was demonstrated that the brake cylinders, operated in the intended sequence, as follows, take-up cylinder, empty cylinder and load cylinder on application and in reverse order on release. The time from movement of brake valve to start of release on Car 70 was 21 sec.



Double Capacity Brake Equipment; Triple Valve Change Over Valve and Two-Compartment Reservoir

No. 5—Automatic Return to Empty Position

The return to empty position occurred on Cars 1 and 70 when pressures were between 15 and 10 lb.

After the completion of Demonstration No. 5 the train was increased to 100 cars by adding 15 cars to each of the strings.

No. 6—Brake Cylinder Leakage

Cocks having No. 8 drill (.199 in. diameter) orifices were opened on five cars adjacent to Car 70, preventing the development of brake cylinder pressure on those cars, while normal pressures were developed in the remainder of the cylinders.

That this intended brake cylinder leakage did not influence the pressure in the brake pipe is evidenced by the fact that while Demonstration No. 6 was in progress the brake pipe leakage was determined and found to be 5 lb. in two minutes from 61 lb. pressure.

Special Demonstration A (Requested)

BRAKE PIPE LEAKAGE CORRESPONDING TO BRAKE CYLINDER LEAKAGE OF DEMONSTRATION NO. 6, ESTABLISHED STEP BY STEP ON CARS IN REGION OF CAR 70

No. Orifices (No. 8 Drill) Open	Brake Pipe Pressure		Brake Cylinder Pressure Car 100
	Car 1	Car 100	
None	69	66*	
1	69	60	†
2	66	47	46
3	65	41	46
4	64	30	45

*Lack of time prevented waiting for complete recharge of train.

†Not observed. (10 lb. reduction of Demonstration No. 1 give 25 lb. cylinder pressure on last car.)

The value of a No. 8 drill orifice is 48 cu. ft. of free air per minute from 70 lb.

Special Demonstration B (Requested)

Quick Action Time on 100-Car Train

Total Length of Brake Pipe (Less Branch Pipes and Engine and Tender)—5,837 Ft.

Time from movement of brake valve handle to piston start on Car 100, 10.7 sec.; rate of emergency propagation, 545 ft. per sec., or 372 m.p.h.

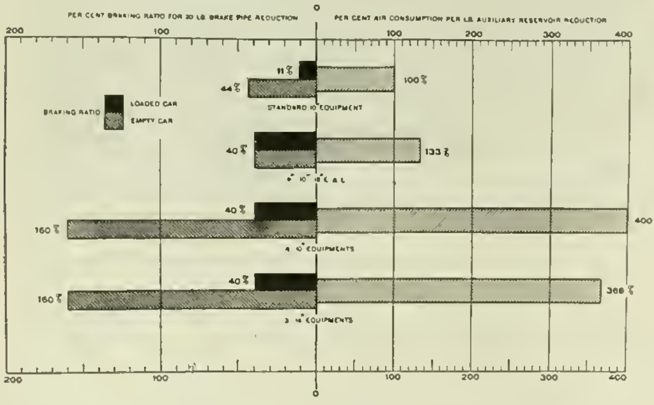
Speed and Air Consumption with 100-Car Train

The speed and brake pipe pressure as recorded on the 100-car train are reproduced herewith. Briefly the record shows the following for the descent of Kellysville and Allegheny grades:

	Length of 1½ per cent grades	Average Speed
Summit to Kellysville	10.5 miles	20.6 m. p. h.
Merrimac to Fagg	7 miles	19.0 m. p. h.

The speed down the Kellysville grade ranged from 18 to 24 m.p.h., except for a reduction to 14 m.p.h. at Oakvale. The air consumption per car was 0.328 cu. ft. of free air per minute.

The train performance down the Allegheny grade from Merrimac to Fagg was a duplicate of the run down the Kellysville grade. At no time did the speed range exceed a 5 m.p.h. variation from the desired mean speed of 20 m.p.h. The air consumption was 0.304 cu. ft. of free air per minute per car.



Comparative Braking Ratios and Air Consumption for Various Brake Equipments

Handling a Train of Empty Cars

On Thursday, May 26, a train of seventy-five empty 120-ton gondolas was hauled up the grades from Roanoke to Princeton. During this run tests were made of the empty and load brakes in order to demonstrate the practical elimination of shocks during heavy service and full emergency applications.

The train was hauled by a 2-10-10-2 Mallet to Rich Creek. A full service stop was made west of Salem (about 8 miles west of Roanoke) from a speed of 18 miles an hour in 38 seconds with a brake pipe reduction of 12 lb. A full emergency stop was made on the grade near Eggleston (about 55 miles west of Roanoke and 22.6 miles east of Rich Creek) in 18 seconds from a speed of 20 miles an hour with the brakes in the light capacity position.

Demonstration With 75-Car Train

The concluding run of the demonstration was made on May 27, from Princeton to Roanoke with a train of 75 loaded 120-ton capacity cars and the observation car. The gross weight with the locomotive was 12,519 tons; without the locomotive 12,070 tons. As on previous occasions, a brake pipe pressure of 75 lb. was maintained.

Five cars in the train (15th, 30th, 45th, 60th and 74th) had open drain cocks in the cylinders. The speed fluctuations did not exceed 5 m.p.h. for any brake cycle except on the observance of a 10 m.p.h. slow order at one point a short distance east of the summit. The average speed down the Kellysville grade was 17.6 m.p.h. and from Merrimac to Fagg 19.2 m.p.h. The air consumption was 1.12 cu. ft. of free air per minute per car on the Kellysville grade and 0.97 cu. ft. on the Allegheny grade.

Just east of Rich Creek station, on a .9 per cent descending grade, an emergency stop was made from a speed of about 27 m.p.h. As measured by rail lengths, the stop distance was 760 ft. The slack was stretched prior to the emergency brake application and the run-in was even milder than that of the preceding day's test.

Watching Recording Apparatus on Observation Car

With a view of making this test under more critical conditions, a repeat at about 13 m.p.h. was made just east of McCoy station on an ascending grade of .2 per cent. The slack run-in at the rear end came just at the stop, and while more noticeable than in the first test, was very mild, being insufficient to move a camera in a leather case acting as an improvised slidometer on a planed board bench. The stop distance according to rail lengths was 230 ft.

The train was handled between Merrimac and Fagg with the same uniform control as on Kellysville grade, including a slow down for orders at Elliott, with a total variation of speed of from 13 m.p.h. to 23 m.p.h.

The train arrived at Roanoke at 3:10 p. m., a total of 8½ hours elapsed time, showing the practicability of handling a 12,000-ton train in regular traffic in reasonably close to an eight-hour period.

Pyrometers Promote Locomotive Efficiency

The Value of Pyrometers Applied to Superheater Locomotives Has Been Proved by Many Service Tests

As a positive check on the efficiency of superheater locomotive performance, pyrometers* have demonstrated their great value. They register steam temperatures at all times, and enable engine crews to keep a constant check on the fire, water level, draft conditions and locomotive performance generally. A locomotive cannot be operated without a steam gage. Why should it operate without a temperature gage since its efficiency is dependent upon the degree of superheat attained?

To illustrate the importance of pyrometers, a hypothetical case is assumed of a locomotive operating without one and hauling a specified train load on a regular run. Suppose that the locomotive operates on the first trip all right as far as steaming and fuel consumption is concerned. A front end air leak may develop on the second trip and easily pass overlooked for a day or two. Gradually the engine crew notices an excessive coal consumption, and finds difficulty in keeping up steam. As the leak becomes greater the flues get dirty, the fireman is finally unable to keep up steam pressure and the locomotive fails on the road.


Location of Pyrometer Indicator in Cab

When locomotives are equipped with pyrometers, however, troubles are apparent as soon as they develop, and can be corrected. Any defect which tends to decrease the gas temperature and resulting steam temperature is immediately reflected in the pyrometer. A low steam temperature warns the enginemen that something is wrong and when this is reported at the end of the trip, the roundhouse force can locate and correct the trouble before the locomotive goes on the road again.

It is important that engine crews be instructed as to the purpose of pyrometers and this instruction should require but a short time since they already know that the efficiency of a superheater locomotive depends upon the amount of superheat attained. A crew, trained to operate a locomotive equipped with a pyrometer, can check its operation and know when it is working at highest efficiency. Defects in operation, being made apparent by a low steam temperature reading, can be quickly corrected and with a little practice, avoided. The net result is a saving in fuel and more efficient locomotive operation.

Defects Shown by Low Pyrometer Readings

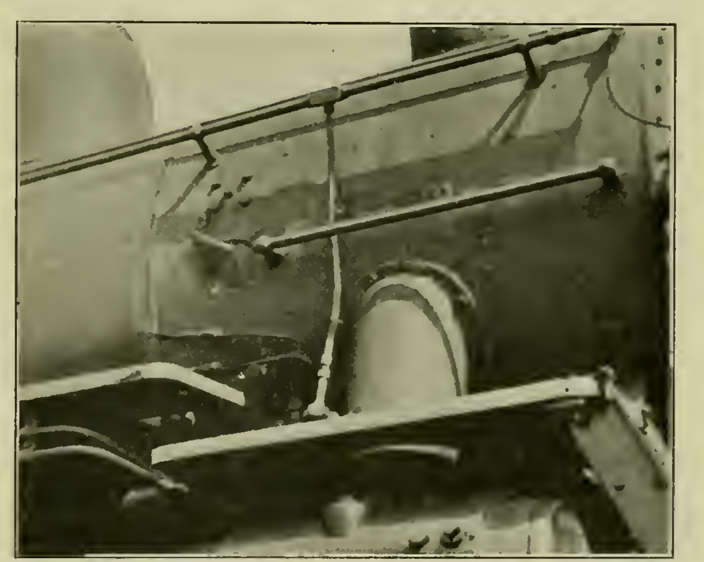
Where pyrometers are being used, many enginemen depend more completely upon their indications than upon the steam gages. When a locomotive is working under average conditions, and a perceptible drop in steam temperature is noted, some of the following defects either in the operation or the condition of the locomotive may be looked for.

First—The water level in the boiler may be too high, causing priming. The superheater then has to evaporate the water in the steam and consequently the final temperature of the steam is reduced.

Second—The fire may not be in a proper condition, due to too heavy or too light firing. Either condition will reduce the firebox temperature and consequently the final temperature of the steam.

Third—A portion, or all, of the large boiler flues may be stopped up.

Fourth—Air or steam leaks may be present in the front end, a condition which seriously affects the draft.


View Showing Steam Fixture in Steam Pipe and Connection to Cab Through Handrail

Fifth—The damper may not operate properly and interfere with the passage of gases through the flues.

Any one, or any combination of these defects will cause a reduction in steam temperature which is immediately indicated by the pyrometer.

The first two of these conditions can be prevented or corrected by the enginemen; the last three should be reported for attention at the terminal. Prompt attention to these conditions will save hundreds of thousands of dollars for the railroads, not only in fuel, but in eliminating delays and preventing minor repairs from becoming costly. Advantages resulting from the use of pyrometers would seem to warrant the general application of these instruments to all superheated locomotives.

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*The detailed description of a pyrometer completely adapted to locomotive conditions and able to retain its accuracy under severe usage is given on page 1721 of the June 24, 1919, Railway Age.

Suggestions for Improvements in Locomotives

BY JOHN MITCHELL

The average railroad man usually has some suggestions to offer for solving any problem which may arise. Many things require more or less frequent attention due to some neglected point in design or application, or by a failure to give the necessary attention at the proper time. A more frequent mention of the every day problems of the man in the roundhouse and in the shop with a discussion of the possible changes which would tend to improve conditions, would undoubtedly assist in the solution of many such problems. With this object in view, the following suggestions, gathered from various sources, are presented for consideration.

Lubrication

This always has been, still is, and will continue to be a live issue, as the life of moving machinery is dependent to a large extent upon the proper lubrication of bearings and other surfaces in sliding contact. Hydrostatic lubricators are in general use on locomotives, but it is surprising how little attention is given to their performance. Sometime ago one of the first-class roads undertook to find out how many of their engines had the oil pipes so applied that the oil would flow from the lubricator to the steam chest without being retained in sags in the pipes. The pipes were disconnected at the lubricator and at the steam chest. One man then poured a quart of oil into the pipe at the cab end, while another man with a can of the same size caught what came out at the steam chest end. Any deficiency would indicate the amount retained in pockets or sags. As the lubricator cannot supply a uniform feed of oil unless the pipes have a continuous fall, a test, such as outlined, should be made at least every time an engine is given a general overhauling.

A leaky lubricator throttle valve is a common occurrence and every one wastes some oil whenever the filling plug is removed, as well as being a source of danger. As a rule the men who fill lubricators do not regularly report defects on engines, consequently, unless the valve leaks so badly that it is impossible to fill the lubricator, the condition is not reported and repaired. These valves should be systematically examined and repaired if necessary. In such places it is advisable to use a high-grade standard valve so that a leaky one may be replaced by another valve and the defective one repaired at convenience.

Driving Boxes

The driving boxes in common use today differ but little except in size from those used years ago. This is a good field for the practical inventor. The advantage of cutting out the brass in the crown so that the journal may not have a bearing at this point is quite generally recognized. This enables the brass to wear to a perfect bearing without becoming pivoted with consequent wear and pounding on the sides. Most roads follow the practice but do not carry the principle far enough for it is entirely possible to cut out enough of the crown of the brass to control the wear and cause it to be uniform over the entire bearing surface. No general rule can be laid down and it is necessary to experiment with different classes of engines to determine the most satisfactory width for the slot in the crown. The heavier the engine, the wider the slot should be made. On some heavy power the width is three inches or more. The proper size having been determined by tests, brasses can then be cast with the slot cored in.

Reversing Gears

Modern heavy locomotives made necessary the adoption of the power reverse mechanism, but it has also proved to be an economical addition to lighter engines, particularly those in switching service. It is positive in action, invaluable in an emergency, a good all-around safety device and as it saves the time and strength of the engineman, offers greater assurance that he will use the proper cut-off by hooking up the engine when it should be done.

Power reverse gears have their faults, of course, among them being the tendency to creep unless properly maintained, the tendency to freeze, the necessity of a steam, as well as an air connection, and the absence of flexibility in not being subject to manual operation. A screw reverse operated by a small air motor would overcome these weaknesses, permit of closer adjustments of cut-off, obviate the necessity of a steam connection, do away with creeping, simplify the mechanism and be a real safety device as it could be operated instantly by hand under any condition. It is strange that such a mechanism has not been developed.

Cylinder Cocks

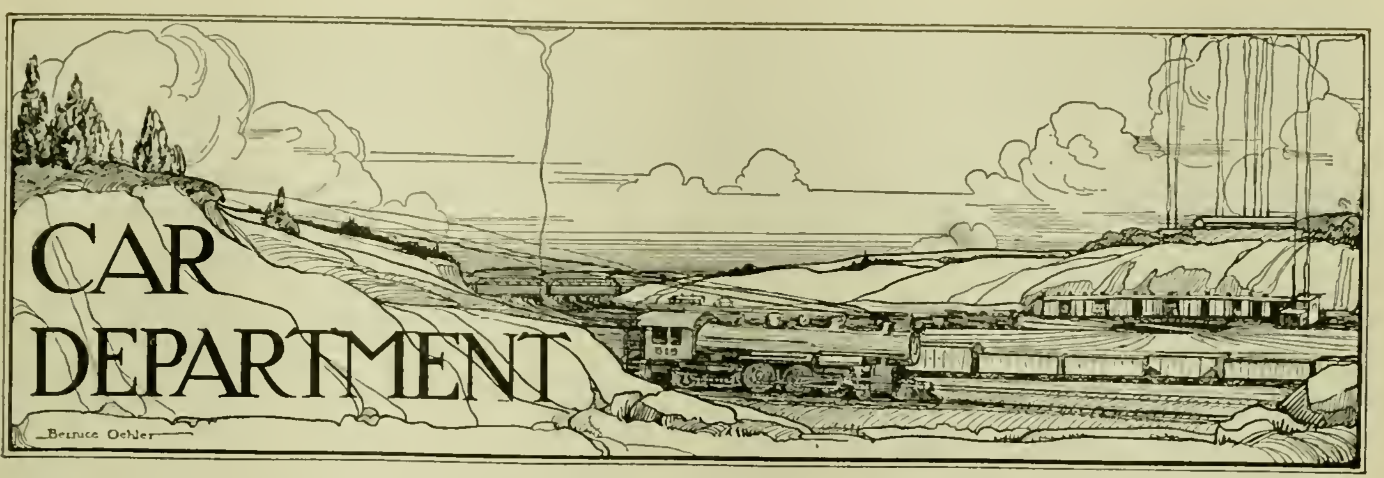
Condensed water is removed from the cylinders by a simple device to which but little attention is given although considerable money is lost due to the neglect of maintenance. Cylinder cocks with a discharge opening not over ½ in. in diameter are still used, despite the fact that such an opening is entirely inadequate to discharge the water from an 18 in. or larger cylinder. These cocks should have sufficient opening to discharge all the water in one revolution, provided the engine is moved off slowly. This would require the use of an opening of about 2 in. diameter, and would probably necessitate the development of a gate or quick opening valve. Cylinder heads are often knocked out, cylinders cracked or broken, piston packing broken, lubrication destroyed, rod packing cut and steam leaks either started or aggravated, largely due to the use of cylinder cocks of inadequate capacity for large engines.

The operating mechanism of cylinder cocks is commonly neglected as the importance of its maintenance is not properly emphasized. This is particularly true of the air operated mechanism used on Mallet locomotives where the four air cylinders are located underneath the bottom guides, in which position the vibration of the guides and the close proximity to the ground frequently make them inoperative. As simple a device as the cylinder cock rigging should be so designed that it would require repairs only at infrequent intervals. Any device which requires repairs practically every trip will inevitably be badly neglected.

To overcome the conditions referred to on Mallet locomotives, one road has developed an arrangement which consists of only two cylinders made of 3 in. pipe, these cylinders being located midway between the frames on a suitable brace, one for the high pressure cylinder and one for the low pressure. The power from the air cylinders is transmitted to the cylinder cock slides through a substantial shaft, to each end of which is attached a lever so fulcrumed as to give the desired power to move the slides. The mechanism is simple, positive and reliable and the location of these air cylinders is such that they are not subject to fouling and can be so securely fastened as not to work loose. They consequently require but little attention.

A semi-automatic air operated cylinder cock has proved effective on engines other than Mallets. The cock is normally held open by a coiled spring until closed by admission of air to the operating cylinders. The spring is attached to the back end of the cylinder cock slide and held in compression between a lug at the end of the slide and the cylinder cock, thus forcing the slide back and opening the cock.

It is a difficult matter to impress upon shop forces the necessity of using an extra effort to maintain a device which is considered to be of a poor design and while such an attitude may not be justifiable, it is natural and can best be overcome by the installation of an improved device. It will well repay any road to go over cylinder cock riggings with these suggestions in mind and improve them.



Draft Gear Tests of the Railroad Administration

Car-Impact Tests or Symington Test Plant
Methods of Combining and Interpreting Records

In order to obtain an exact knowledge of the action of gears in service, car-impact tests were made, using the same gears as in the foregoing laboratory tests. The results are therefore of special interest as showing not only the action of the gears themselves under service conditions, but as demonstrating also, for the first time, how laboratory tests compare with service action. The gravity testing plant of the T. H. Symington Company at Rochester, N. Y., was used for these tests. In general, the use of private laboratories of interested companies was avoided, the preference being given to the testing facilities of railroads. This being the only plant of its kind in existence, however, and the Symington Company being interested in the manufacture of draft gear attachments rather than of gears, and having no gear in the tests, the Section availed itself of the opportunity to use the Symington testing facilities.

This plant was originally built for investigating the action of full-sized cars, either loaded or empty, when equipped with different draft gears. The Symington Company, who were practically pioneers in this work, constructed the plant with the prime idea of studying the action of the cars when equipped with different gears rather than investigating the action of the gear itself. As originally constructed and used, much valuable information was obtainable from this equipment although, as in any other impact testing, misleading conclusions as to the relative merits of draft gears could be unintentionally reached by subjecting gears to over-solid car velocities. The extended remarks heretofore made regarding over-solid laboratory testing apply equally as well to this service testing. Over-solid testing should never be done except for discovering weak gear construction. Some of the earlier tests have been of value, however, in showing what slightly over-solid speeds are necessary to produce gear injury and failure. After the owners had made certain changes and additions desired by the Section for a more exact investigation of both gear action and car action, at speeds within the ranges of the gears, the Symington plant was taken over and operated by the United States Railroad Administration for the purpose of the car-impact tests.

The Symington Test Plant

The testing plant of the T. H. Symington Company, the instruments used and the records obtained were described in the *Railway Mechanical Engineer* for May, 1919, page 249.

In general this test plant consists of a test track with two full-sized cars which can be caused to collide at any desired velocity, accurate means being provided to record the results. The first portion of the track is inclined in order to impart velocity to one of the cars. An electric winch is located in a small house at the top of the incline and this winch through the medium of a puller car, is capable of drawing a loaded 50-ton car up the incline. At the foot of the incline is a section of approximately level track which terminates in a section of track on an ascending grade. The track is straight throughout its length.

Two composite gondola cars of 50 tons capacity are used, one of which, termed for reference car "B," is spotted at a certain point at the beginning of the 1 per cent grade. The other car, termed car "A," is drawn up the incline by means of the puller car and winch. A movable trip block is clamped on a third rail located alongside the track. The puller car has a projecting trip-lever which strikes the trip block, releasing car "A" and allowing it to roll down the incline. When fully on the level portion of the track, car "A" collides with the standing car "B." Either or both cars may be equipped with draft gears of any type, and both cars are free to follow such movement during and after the draft gear cycle as may result from the use of the particular gear.

The test cars are 50-ton low side, composite gondolas, 46 ft. 0 in. inside length with fish-belly center and side sills and with a steel frame superstructure. The cars have 2¼ in. floor planking and 3¼ in. side and end planking. Each of the cars has four diagonal floor braces of 5 in. channels at the corners, and each has been supplied in addition with four diagonal braces at the center, extending from the side sills to the center sill. The light weight of each car is 47,800 lb., and they have been loaded with pig iron to give a total gross load of 143,000 lb. per car. Wood cribbing is arranged inside of the car to hold the lading against shifting. The brakes were removed from the cars to avoid any possibility of dragging shoes.

The test cars are equipped with Farlow Two-Key draft gear attachments and the test gears may thus be carefully adjusted in the draft gear pocket. In this arrangement the gear is positioned between the arms of the horizontal wrought steel yoke. In buffing, the gear seats against the rear follower, which latter bears against the rear of the yoke. The yoke in turn seats against the cast steel back-stop and bolster center casting. This casting bridges between the sills and ties them together, there being a total of seventy-four ¾ in. rivets supplied for transferring the buffing force from the backstop casting to the center sills in each of the test cars. The draft gear is held to compressed position by means of the second draft key, which in service forms also the front pulling stop for the gear. The regular practice in this form of attachment is to have this key protect the draft gear by allowing it to strike the ends of the slots in the check plates and sills at the same time the gear goes solid. In the tests, however, the slots were lengthened at the rear to prevent this key ever going solid.

A dummy coupler having a flat buffing face and of 16 sq. in. cross sectional area, was used instead of a standard coupler. The front key, which passes through the key slot of this coupler and through the front slots in the yoke, was used in these tests for supporting and aligning the parts only. The front end of the dummy coupler shank was guided both vertically and laterally. In all tests care was taken to see that the draft gears seated against the second key and not against the coupler key. The artificial looseness or slack resulting between the coupler butt and the front follower was taken up by temporary wedges before each run so that all action, both on compression and release, could be restricted to the gears themselves and be definitely measured and recorded.

Action of Cars During Impact

In any case of car-impact, the first and prime effort is for the velocities of the two cars to equalize; that is, for car A to slow down and car B to speed up. This is caused by the effort of car A to push car B ahead, which continues as long as the velocity of car A is greater than that of car B. This pushing or propelling effort must always result in the compression or yield of some part or parts of the car. The draft gears are supplied for the purpose of providing this yield and to reduce the amount of yield required from the car structure.

But in every case of impact, some part or parts of the cars, either draft gears or other more rigid car parts, will continue to compress or yield until the very instant when the velocities are equal. For light impacts, the velocities are usually equalized without compressing the draft gears to their full amount. In the case of an over-solid velocity, the draft gears will first be fully compressed, their resistance slowing down car A and speeding up car B. But in this over-solid case, when the gears are fully compressed, car A has still a greater velocity than car B and it will be apparent that car A will continue to urge car B forward. This results in an impact directly upon the gear housing.

The additional work to be done must be accomplished by certain forces working through a certain space represented by the additional yield of the solid parts, the force going directly through the housing to the sills. The couplers, gear housing, and sills must now continue to yield until the car velocities are finally equalized. The amount of yield and the magnitude of the forces are inversely proportional and depend entirely upon the sturdiness of, or the resistance offered by, the parts. The sturdier the parts, the more force will be required to deform them and the less will be the amount of penetration and yield and incidentally the lower will be the unit stress. On the other hand, the lighter the parts the greater will be the yield and the less the force, but the higher will be the unit stresses. Accordingly, although providing a temporary cushioning for the over-solid blow, the lighter parts will shortly be deformed or broken. Any weak link, be it coupler shank, draft gear housing, draft lugs or center sills, will reduce the force peak but only at the expense of its life.

The velocity of car A is thus being gradually decreased and that of car B increased until the velocities are equal, at which instant all parts have reached the maximum of compression. If all of the parts were perfectly inelastic, if in other words, there should be no tendency for the gears to release themselves or for the car structures to give back the energy of their elastic yield, it is evident that there would then be no force of recoil to separate the cars, and both cars would accordingly move off together at this equal velocity. With equal rolling and grade resistance, the cars would continue together until both finally came to rest without separation. Except for the slight loss due to rolling resistance, the work done in compressing the gears and car structure is thus always equal to one-half of the original kinetic energy in car A, and it should be especially noted that this is the same whether there be no recoil of the gears and car parts, or full recoil.

The force exerted between the cars in compressing the gears and car structure is entirely independent of the question of absorption. Up to the point of maximum compression the matter of absorption of energy has not entered into or influenced the problem. It is entirely a question of force and yield and it should be remembered that frictional resistance, while truly absorbing energy (foot-pounds) does not in any manner whatsoever reduce or "absorb" force. The force required to close a friction draft gear, and consequently the force going through the gear to the sills, may be greater or less than a spring draft gear of equal capacity, depending solely upon its compression curve, and not in the slightest degree upon its percentage of absorption. The cushioning value of a gear therefore is not measured by absence of recoil, or energy absorption, but solely by its action during the closing period. Whether or not a gear has extensive recoil has nothing to do with its action on compression, or with the force delivered by the gear to the car during its compression.

In practice, the cars having reached a point in the draft gear cycle where their velocities are equal, and the compression period of the cycle completed, the release of the gears begins. All gears have more or less recoil and it is this force, together with the rebound of the car structure, that tends to part the cars and to cause one car to travel faster and farther than the other. It should be especially noted that the force of recoil has the same effect between the cars as the force of compression; namely, to reduce the velocity of car A and to increase the velocity of car B. During the period of gear compression the force between the cars, or the force tending to accelerate car B, results from the higher velocity of car A, or its direct tendency to push car B ahead. During the period of draft gear release, the force tending to further accelerate car B or to urge it forward, results from the recoil or return of stored energy in the two draft gears and both car structures.

The recoil of the gears and car parts thus giving to car B a greater velocity and to car A a lesser velocity, car B will begin to travel faster than car A, and the gears, following the resulting parting of the cars, will continue to release until final separation of the cars. It is evident that the greater the force of recoil, or release, the greater the pressure between the cars during release, and consequently the higher will be the velocity attained by car B and the greater the retardation of car A. A gear with 100 per cent recoil would actually bring car A to rest by the time the cars separate, while car B would be pushed ahead at a velocity practically equal to the original impact velocity of car A. On the other hand, a gear with no recoil, or 100 per cent absorption, would, as heretofore set forth, cause both cars to move off together, each at one-half the initial velocity of car A.

Gear absorption is thus inversely proportional to the pressure exerted between the cars during the period of release, the effect of high absorption being to hold the two cars at nearly equal velocities after impact. This means, in effect, that with high absorption of energy, car B will not be propelled at so high a velocity and consequently will strike the next succeeding car at a reduced velocity, while with no absorption, car B will strike the next car at almost the same velocity as the original of car A. Absorption therefore is not primarily a means of reducing the force of impact between the first two cars, or of protecting these cars, but is a means of reducing the magnitude of the successive impacts between successive cars in a train.

The following may be accepted as general principles of draft gear action in impact:

1. That draft gears are compressed only because of differences of velocity between adjacent cars.

2. That the resistance offered by the gear during compression tends to overcome the difference of velocity of the cars and tends to bring both cars to the same velocity.

3. That gears continue to close, and at over-solid velocities the car structures continue to compress, until the car velocities are equalized.

4. That this action of a gear is independent of its ability to absorb energy, or in other words, is the same whether the resistance be obtained from friction or from spring action.

5. That the cushioning offered by the compression of a draft gear is not dependent upon its percentage of absorption.

6. That absorption does not in any manner reduce the force going through the draft gear to the car sills while the gear is being compressed, and does not lower the force exerted between the first two cars colliding. That it does act to lower the velocity with which the second car strikes the third car and consequently reduces the force between successive cars.

7. That the amount of "work-absorbed" by a gear, or the percentage of absorption does not regulate or reduce the force of first collision, but is important as determining whether shocks will run practically undiminished throughout the train or whether there will be successive reductions in their magnitude from car to car.

8. That the first measure of a draft gear is the amount of energy required to close the gear, this being the sole factor from which to determine for what switching speeds a gear is suitable. This is expressed as "work-done" and has no relation whatsoever to "work-absorbed."

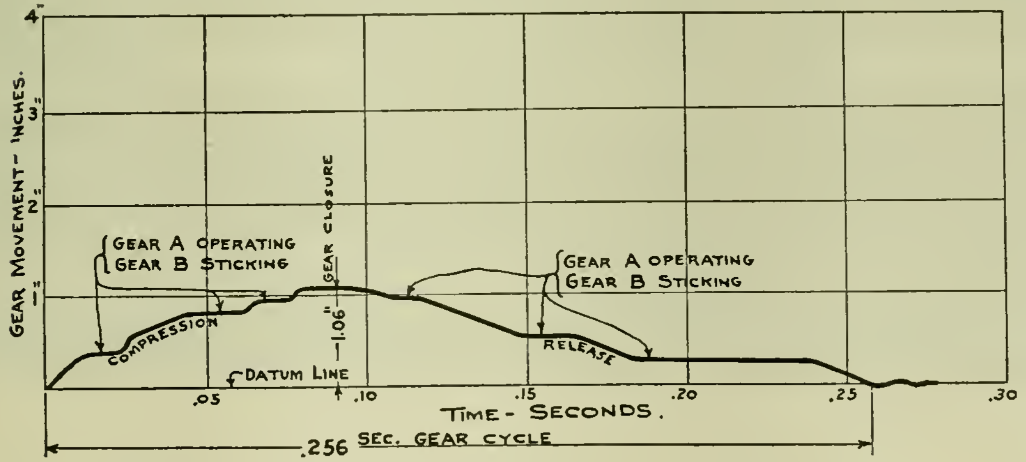


Fig. 4—A Typical Time-Closure Curve Produced on the Small Drum of Car B

9. That the next requirement is that a gear, either spring or friction, shall compress with such a rate of increase of resistance as will cause the lowest practical ultimate force and the least practical vibration of the car structure.

10. That the next measure is with respect to the action of the gear on release or the amount of the recoil, whether the energy of compression is returned, to go on to the next car, or whether it is partially absorbed as by friction. This property is expressed by the term "work-absorbed."

Records in Car-Impact Tests

In the car-impact tests the following records were taken: impact velocity of car A; travel of cars along track; draft gear travel and action; seismograph readings and graphs of car action.

From these prime records a complete study of the action of both the gears and cars can be made, the details of which will appear as the manner of making and interpreting the several records is discussed.

Impact Velocity

The first information needed in such tests is an accurate knowledge of the velocity of car A at the very instant of impact. In these tests car A was caused to draw a velocity line upon a revolving drum, so that the exact velocity at the very instant of impact is obtained within a possible error of less than 1 per cent.

Travel of Cars Along Track

An interesting point in connection with this record is that for equal impact velocities, the higher the recoil of the gear used, the greater the distance car B will travel. In general, the recoil of gears will be proportional to the distance between the cars after coming to rest; that is, the greater the recoil the farther apart will be the cars when they have finally come to rest.

Draft Gear Travel and Action

Knowing the impact velocity, the next point of interest is the amount of and the nature of the travel or yield of the draft gears. The test cars are equipped with friction plunger gages to show the amount of coupler travel. This corresponds reasonably closely with the actual draft gear travel, but is not sufficiently accurate for analytical investigations.

In order to obtain a more direct knowledge of the movement and action of the gears, car B is provided with a small revolving drum upon which is drawn a curve which shows not only the amount of draft gear movement for that car but the character of the movement; that is, whether the gear compresses and releases regularly or irregularly. A case is secured to the side sill of car B in which is a small motor-driven drum which extends transversely of the car. A pencil is caused to move lengthwise of the drum in harmony with the movement of the front draft gear follower. The drum is covered with paper, and as the gear is compressed or released the pencil is moved a corresponding distance along the axis of the revolving drum, and thus produces a time-closure diagram for the gear in car B.

Tests were in each instance made with gears in both cars and again with a gear in car B only, car A in the latter case being fitted up with a solid steel block instead of a draft gear. The action of the individual gear can be best studied under these latter conditions because it is definitely known that any irregularities recorded are due to the particular gear. In the former case the record does not determine which of the two opposing gears is responsible for the irregularities. Such irregular action is almost invariably recorded when both cars are equipped with gears. The specimen card reproduced in Fig. 4 was made from the gear in car B when each car was equipped with a friction draft gear. This card shows the typical action of friction gears in the double-gear tests, or when both cars are equipped with gears.

By means of these cards it is found that while some draft gears act smoothly and regularly, others, particularly those from friction gears of high capacity, are often closed by a succession of alternating movements or jerks. This will be shown as the individual cards are reproduced. The lower capacity gears naturally show smoother gear action than those of higher capacity. The cards show that with a gear in each car, the two gears do not work in harmony; that frequently on compression, and almost invariably on the release, one gear will work for a while and then the other one will operate. From this it is concluded that twin arrangement of friction draft gears is not permissible.

Seismograph Readings

Each of the test cars is equipped with a pendulum device, secured to the side of the car, and so arranged that the retardation or acceleration of the cars will cause the pendulums to swing upward by virtue of the inertia of their own masses. Graduated quadrants are arranged as guides for the pendulum weights, and a light friction runner is carried with the weight and is left standing upon the guide at the highest point reached by the pendulum. The seismograph records are usually attractive to the observer but are not of great importance in the study of gears.

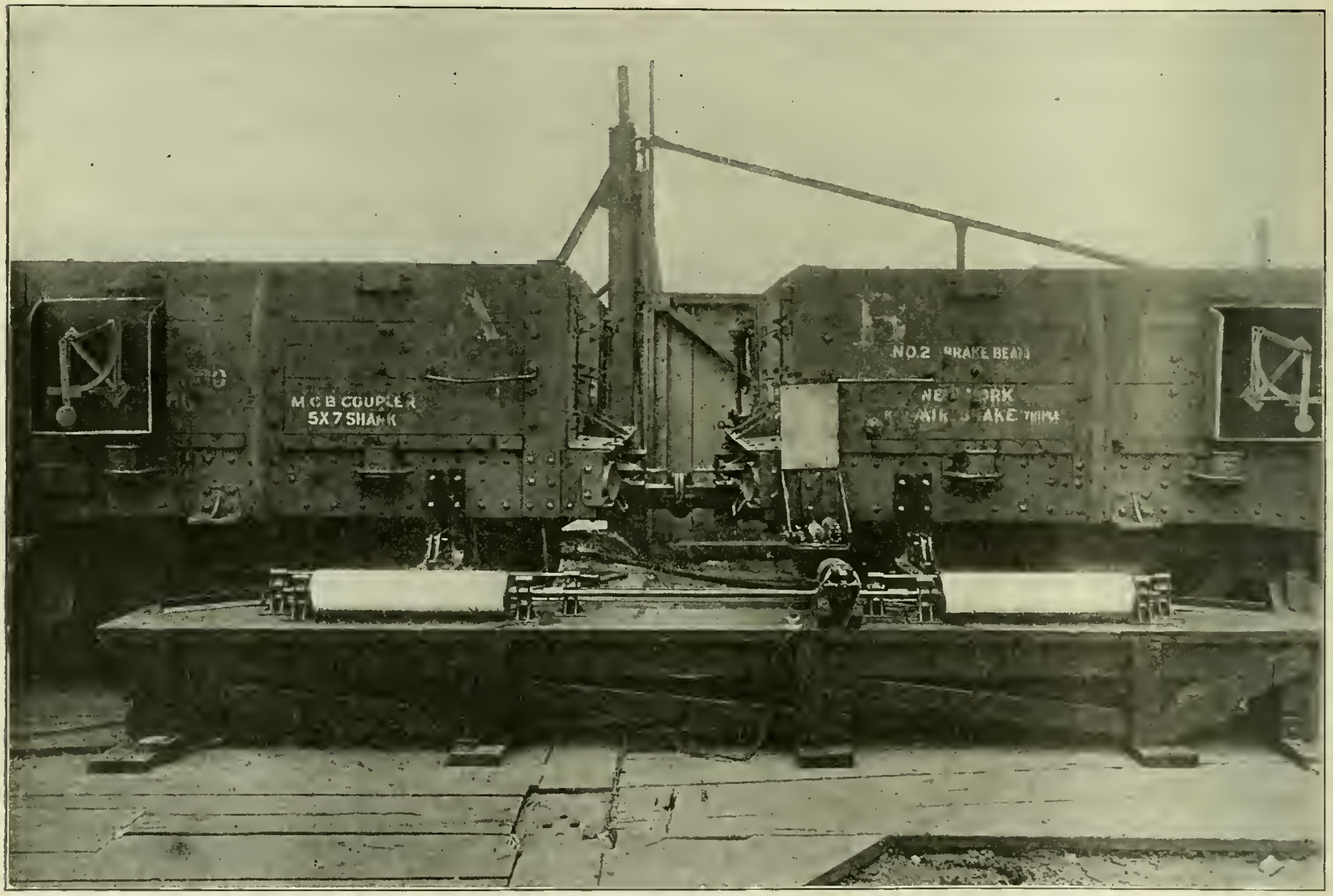


Fig. 5—Instrument for Recording Car Action

Graphs of Car Action

As the final study of draft gear action must lie in a study of the results of the use of the gear upon the car and its lading, arrangements were made to obtain a complete and accurate record of the performance of both cars during the brief period of the draft cycle. A recording apparatus, arranged to draw simultaneous time-displacement curves of both cars, was designed and installed and a system of certain reference lines worked out whereby these curves could be later so super-imposed that at any instant during the draft gear cycle an exact knowledge of the performance of both cars could be had. These curves are commonly referred to as "car-movement curves." A photograph of the instruments for producing these curves is shown in Fig. 5. The apparatus has two drums mounted upon a common shaft and is placed on a stand alongside of the track. The drums are so mounted upon the shaft that one drum is alongside of the striking end of car A and the other alongside of the struck end of car B. Each drum has a pencil carriage that is moved lengthwise of the drum by the movement of the car, each car having a pencil-propelling plunger attached to its side sill. Suitable angle iron guides are arranged upon the instrument stand to cause the plungers to move into or out of engagement with the pencil carriages at the proper times.

Making a Test Run

Car B is spotted, always at the same definite station along the track. Car A is also spotted, the buffing faces of the couplers being just in contact and all loose slack being eliminated or compensated for. With the cars so spotted and with the A and B pencils in positions on their respective drums corresponding with the positions of cars A and B respectively, the drums are rotated a few times, thereby drawing the datum lines, (see Fig. 6). At the same time the small drum is rotated a few times so that its pencil draws the datum lines for this record. It will thus be seen that all of the datum lines are drawn with the cars and gears in position as at the first instant of impact; or, in other words, at the beginning of a true gear compression. Accordingly, in comparing the cards, it is definitely known that all car movements and gear action can be compared from these common datum lines.

Without rotating the drums, each of the pencils is given a slight longitudinal movement, in order to draw the reference lines. The pencil for car B is left standing exactly upon the datum line. Car A is then drawn away from car B and the pencil for car A is drawn along the axis of drum A in order that the approaching car A may propel this pencil for some distance before the pencil reaches the datum line, or the position where the two cars first meet.

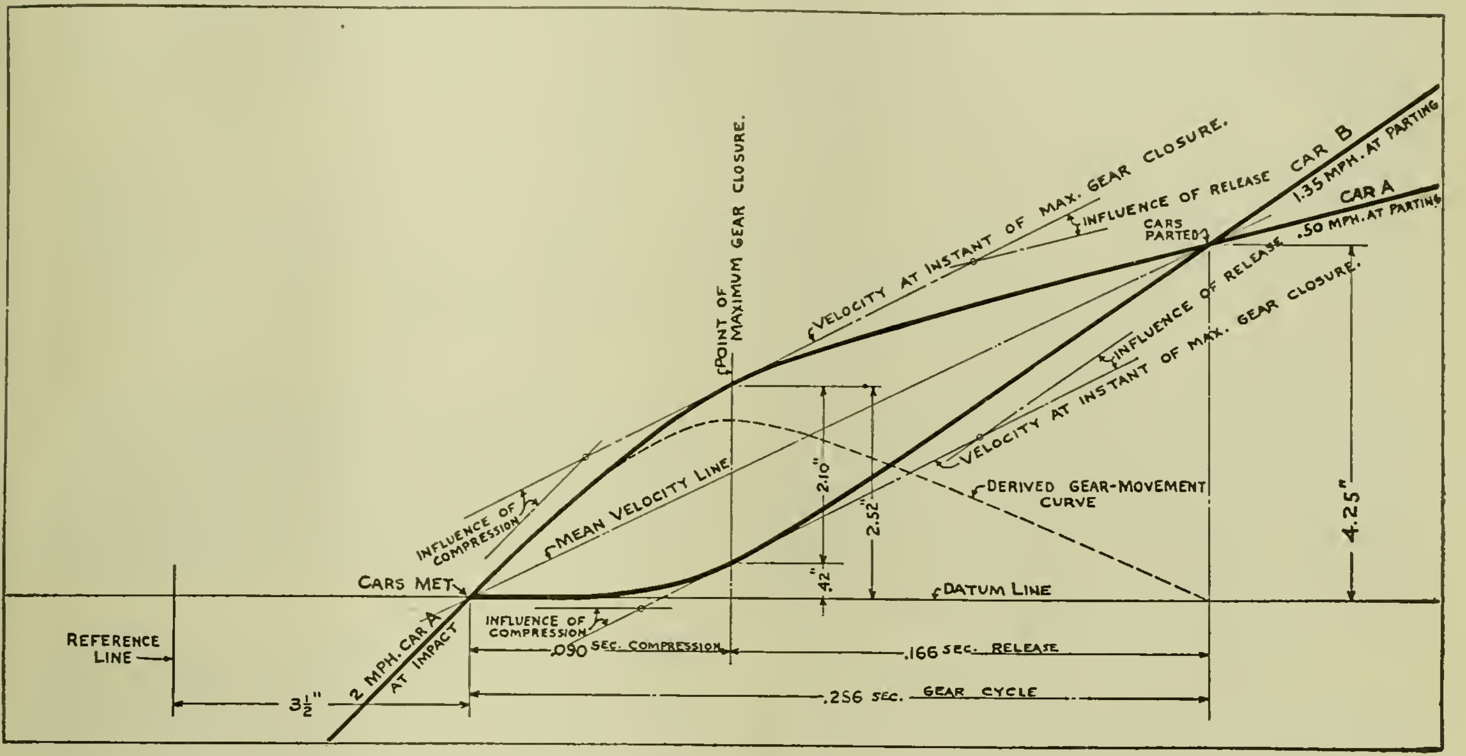


Fig. 6—Specimen Car-Movement Cards from Drums A and B Superimposed

By means of the datum and reference lines on these two cards a system of super-imposition of the two curves has been developed and in Fig. 6 these curves have been so superimposed. This is done by matching up both the datum and reference lines and tracing one curve upon the other. The exact meeting point of the cars is thus established for both curves and both are also synchronized as to time. Consequently both the velocity of the cars and their relative positions can be determined for any instant. And at any instant, also, the distance either car has moved from its spotted positions is known.

It will be seen that car A, during the first portion of the draft gear cycle continued to travel at a higher velocity than car B. As car A thus encroaches upon car B the draft gears are compressed, the distance between the two super-imposed curves representing draft gear compression, together with the slight yield of the car bodies. Car A continued to run down upon car B, its velocity gradually decreasing and the velocity of car B gradually increasing due to the draft gear forces exerted between the cars, until both cars were of equal velocity. This point corresponds with the point of maximum draft gear compression and can be readily determined by finding the maximum ordinate between the two curves.

From this point on, the velocity of car B becomes greater than that of car A due to the forces of draft gear recoil between the cars. Consequently, car B moves away from car A, allowing the draft gears to continue their release. At the point where the two curves cross there is no relative displacement of the two cars, or in other words, each car has travelled the same distance from its datum line, and it is therefore definitely known that at this instant the cars parted and that the draft gear cycle was completed.

From the superimposed curves, Fig. 6, it is possible to obtain a wide range of information concerning car action and draft gear action. The dotted line erected upon the datum line, for example, shows the movement of the two draft gears during compression and release. This curve is obtained by the simple process of stepping off the ordinates between the two curves upon the datum line as a base. The point where this draft gear curve reaches its maximum height is the point of maximum draft gear compression, and a vertical line has been drawn to indicate this point on the curves. From this it is then seen that the period of draft gear compression was 0.090 seconds and the period of release 0.166 seconds, the entire draft gear cycle, or the total length of time the cars were in contact being 0.256 seconds.

At the instant of maximum draft gear compression, car A had moved 2.52 in. along the track from the point of impact, while car B had moved but 0.42 in., car A thus having encroached upon car B for 2.10 in., causing a corresponding amount of gear closure. At this instant, car A ceased encroaching upon car B, as shown by the falling off in gear closure. At the instant of maximum gear closure the velocities of the cars were equal, and the lines established tangential to the car-movement curves at this point denote the common velocity at this instant. These tangential lines also indicate the paths of the car-movement curves had there been no force of recoil, or if the draft gears had stuck. Angles have been drawn in to indicate the influence of gear compression and gear release, and the dimension of 4.25 in. shows the track movement of the cars during the entire draft gear cycle.

The card of Fig. 4 was drawn by the action of the draft gear in car B during this same run. It will be seen that this gear closed 1.06 in., thus showing that the gear in car A closed 1.04 in. While the line in Fig. 6, representing the sum of the actions of the two gears is smooth and regular, yet the individual gears did not operate so regularly. The compression and release was attained by first one gear operating and then the other. This is to be expected from friction gears and indicates variations in the effective co-efficient of friction. No special demerit is attached to this action of a friction gear, as either one gear or the other is operating at all times.

From the superimposed curves it is a simple matter to determine the exact impact velocity of car A and also the exact velocities of both cars at the instant of parting. It is also possible to determine by tangents the change in velocity of each car during any period of draft gear compression or release. It is further possible to plot curves showing the instantaneous velocity of both cars, and from these it is a matter of simple calculation to produce curves showing the instantaneous energies in the two cars. From the rate of change of velocity, the mean or average forces working between the two cars throughout the period of impact may be computed and a continuous time-force curve plotted.

By stepping off and plotting the vertical distances between the superimposed car-movement curves as heretofore explained, a time-closure curve of draft gear action can be produced. This curve will show the complete draft gear action, both compression and release, plotted against time, and in cases where a gear is used in car B only, the curve will practically coincide with the curve drawn by the small drum on car B. This erected time-closure curve, however, includes not only the yield of the draft gears but has added to this the yield of the two car bodies. The uniform practice has been followed of working up and reproducing for each type of gear the following runs:

1. A run, made at or near the closing point, with a calibrated test gear in car B only, car A being equipped with a solid steel block instead of a draft gear.
2. A run made at approximately one mile per hour, each car being equipped with a calibrated test gear.
3. A run made at or near the closing point, each car being equipped with a calibrated test gear.

The first of these is worked up primarily that the action of a single calibrated gear in the car-impact tests may be compared with the action of the same gear in all of the laboratory tests, the possible influence of a second gear being removed The second is worked up that a complete knowledge may be had of the action of each type of gear at low impact speeds. These low speed runs are especially useful in a study of train starting. The third is worked up as showing the best that may be expected from each type of gear at the maximum impact speed it is capable of cushioning, and gives the true comparison of the gears from the standpoint of yard service.

The same gears of a type were used throughout the test, the general practice being to first make tests with both cars equipped, and then after replacing the gear in car A with the solid block, to make the single gear tests.

Means of Preventing Hot Boxes

An interesting discussion on the subject of hot boxes, their cause and the steps to be taken to minimize their occurrence, took place at a recent meeting of the Indianapolis Interchange Car Inspection Association. Some of the factors involved were so well stated by J. C. Stewart, foreman freight car inspectors, Cincinnati, Indianapolis & Western, that the substance of his remarks will doubtless be of interest to others than those who attended this meeting.

The subject of hot boxes is an old one, but nevertheless it is ever of interest on account of its vital bearing on the economical and prompt movement of traffic. Most roads have issued sufficient instructions and blue prints covering the proper methods to be followed in the application and care of packing, but this has not insured proper attention being given to the work. What is needed is a better understanding of the reasons why the recommended practices should be followed. This knowledge can be imparted best to those who have to do the work of inspection and maintenance by holding meetings for instruction, discussion and examination. Moreover, such meetings, if properly conducted, are invariably of benefit in that they induce employees to study, comprehend, think, analyze and reason out the why, how and wherefore of the work on which they are engaged.

The various causes of hot boxes may be classed under two general heads: namely, excessive bearing pressure and defective lubrication. In enumerating the different causes, they can be considered most conveniently by taking up each of these groups separately.

The causes of excessive bearing pressure most frequently met are: journal too small, load in excess of what has been found to be good practice; bearings out of alinement, or truck sides out of square with the axles (all unequally worn brasses removed are evidences of this condition); brass, box and wedge not fitting accurately, due to some improper dimension; wedge bearing unevenly on the brass; bearing warped; bearing or journal rough; bearing raised off the journal by some foreign material, often a short strand of waste; bearing tight on sides or ends; bearing too loose on sides; improper material in brass or lining, possibly too hard to fit readily the journal irregularities; brass cracked or broken, usually caused by being worn too thin before removal; second-hand brass applied; brass with loose lining or lining worn off (on account of the low grade of many of the brasses now used it is safer to depend on the lining for securing even bearing pressure).

Defective lubrication may be due to the use of a poor lubricant, or to not enough oil reaching the journal. Insufficient lubrication may result from any one of the following causes: waste not up against the journal, an insufficient amount in the box; waste lacking in resiliency; waste charred or coated with sand or grit; oil washed out of the box by water or melting snow; oil thick or sticky, oil should flow freely; poor waste, it should have good fibres to carry up the oil by capillary attraction from the bottom of the box to the journal; entrance of foreign material, such as dirt, sand and grit due to missing or defective journal box lids or dust guards; journal boxes with chill cracks, blow holes, broken or defective parts so that the boxes are not closed tightly, oil thus being permitted to leak out and dirt or water to come in; waste not properly prepared; box not properly packed or not re-packed when it should be.

Blue prints showing the proper method of packing boxes are furnished on most roads. Employees should read them carefully and be sure they understand fully the reason for everything.

The majority of the hot box troubles are due directly to improper packing or lack of attention to the packing and can therefore be practically eliminated by proper attention on the part of inspectors. Boxes should not be overpacked by crowding in the packing too tightly which results in waste grabs and prevents a sufficient supply of oil to the journal. Care should be taken to pack properly the extreme back of the box with twisted waste wrung moderately dry, to have the packing put in firmly under the journal with loosely formed packing at the sides, but not above the center line of the axle. When examining boxes and journals care should be taken to ascertain if the packing has shifted from the back to the front of the box, thus leaving an empty space at the back and that part of the journal unlubricated. Pouring oil in the box when the waste has become glazed gives only temporary relief. When packing is found to be glazed on top it should always be thoroughly stirred and adjusted or the box repacked. A failure to repack at the proper time frequently results in a hot box. When there are indications of heating a thorough examination should be made even though from outward appearances all parts are apparently in good condition. It is better not to take chances by passing up an incipient yet bad invisible defect, but endeavor to locate it before serious trouble results.

Packing should be prepared in a tank or leak proof container to insure proper saturation and completely submerged in oil for at least 48 hours. The general practice is then to drain the packing until one pound of waste holds about four pints of oil, when it is ready for use. This work should be performed in a room which can be kept at a temperature of about 70 deg. during cold weather. The use of packing improperly prepared or renovated is simply inviting trouble.

Referring again to the subject of brasses, in order to be safe at all times they should be considered as worn out, missing or defective, when the lining is worn out. The fact that a brass has not run hot before arriving at a terminal does not guarantee that it can run to the next terminal. It should be replaced in time without waiting until it runs hot. Delay may cause needless trouble and expense.

While it is impossible to compute with any degree of accuracy the total cost of one hot box, considering injuries to journals, destruction of waste, oil and brasses and cost of labor together with the loss of revenue caused by delays, the expense is certainly larger than one would expect. A renewed effort on the part of inspectors can greatly improve the condition now prevailing in most places.

Modifications in Rules Proposed by C. I. C. I. & C. F. A.

Prices for Labor and Material; Settlement for Damaged or Destroyed Cars; Passenger Car Rules

THE A.R.A. Code of Interchange Rules was discussed at a meeting of the Executive Committee of the Chief Interchange Car Inspectors' and Car Foremen's Association held on March 3 and 4. Part of the discussion and recommendations were given in the April, May and June issues of the *Railway Mechanical Engineer*. The remainder is given below.

Rule 107 *(Continued)*

M. E. Fitzgerald: Referring to page 123, Items 25 and 25A in connection with body bolster, Item 25 refers to body bolster with top flange, R. and R. and allows 12.4 hours time which includes the R. and R. of draft timbers. Item 25A gives labor charge of seven hours and five-tenths for body bolster without top flange. Many cars are equipped with steel arms with bolsters having a top flange which do not require the R. and R. of arms, and roads are charging the 12.4 hours. As the rule reads, they are permitted to do so for any body bolster equipped with top flange. I move that incorporated in Rule 107, Item 25A, should be a reference to cars so constructed, that a labor charge of only 7.5 hours should be allowed, where not necessary to R. and R. arms.

The motion was seconded and carried.

Mr. Jameson: Rule 107, Item 123 reads: "Coupler yoke bolts, renewed, one or two, at same end of car (coupler not R. & R.)" and allows one hour for ordinary car or refrigerator car. What is the proper labor charge for the renewal of coupler yoke bolts at the same end when it is necessary to R. and R. a riveted yoke coupler, it being understood that our defect card is attached to the car for yoke bolts in place of rivets. I move that Item 123 be changed to read, "Coupler yoke bolts renewed, one or two, at the same end of car when coupler is not R. and R., one hour; when coupler is R. and R., on a bolt basis."

The motion was seconded.

F. H. Hanson: Does that refer to where you make emergency repairs in the yard? Like all roads, we find one coupler yoke rivet broken or missing and then apply the bolt. I do not know where we can R. and R. the coupler when we are applying bolts. We are applying rivets in those cases.

Mr. Jameson: The points where I know bolts are applied are where there are no blacksmiths. We ship them as many couplers as is consistent, with the standard yokes for our own equipment, but it frequently happens that a coupler is broken and it is a yoke different from any size they have riveted on; therefore, it is necessary at this outside point to drop that attachment, cut off the rivets and put in bolts instead.

M. E. Fitzgerald: If at a point like that you drop the coupler and put in the bolts, this rule allows you only the hour and does not provide for the R. and R. of the coupler. If you apply your defect card, it goes home to the owner. He will bill you the labor charge allowed for R. and R. coupler and application of rivets. You have served his purpose, moved his car, and I feel that you should have the R. and R. labor charge where that is necessary.

The motion was carried.

Mr. Jameson: I am asked very frequently, "What labor charge shall I use for packing sills?" Under the rules I have so far been unable to find them, that is, the solid timber used on a great many of our gondola cars, between the center sills.

M. E. Fitzgerald: You would be entitled merely to material charge, but no labor charge. The labor charge for sills or splicing is so made as to include the variation between the different types of equipment.

M. E. Fitzgerald: Item 296 specifies various appliances and attachments to cars that are included with the R. and R. of side plate. I see no mention made of labor charge for the R. and R. of doors or door tracks which are essential in the majority of equipment. I move that the R. and R. of door and door tracks be specified.

The motion was seconded.

A. S. Sternberg: The first rule in 107 covers that.

M. E. Fitzgerald: The rule specifies what is included. Roads are following that and billing us for the door and door track and claiming that it is not so specified. I merely want to specify it in there by adding the words, "Door or door fixtures attached to."

M. E. Fitzgerald: May I again state that the rule is so written that it includes various items. If the preceding item would cover roofing fascia, etc., why refer to it? Everybody knows it is there.

Mr. Owen: I believe that that door track was left off purposely. There is overlapping labor on that plate. Your corner bands, fascia and everything goes in with it. When it comes to the side door, side tracks or door fixtures, that is an extra charge. It should stand as it is, as an extra charge.

M. E. Fitzgerald: That is why I bring the question up. Mr. Sternberg says it is included and quotes the "unless otherwise specified" references. Mr. Owen says it is not because it is not referred to. You could not take technical exceptions to everything or you would be tied up in the billing department. These should be so written that the billing clerks will understand that this is included, as I think it is intended it should be.

The motion was carried.

Mr. Jameson: Rule 101, Item 101: "Altering height of one end of car shimming springs, net (this includes renewing of shims), $2.85." Rule 107, Item 420: "Wheels, cast iron or cast steel, R. and R., or R., including jacking car, pressing wheels, off and on, boring wheels, all necessary machine shop labor on new or second-hand axles." Will any reduction be made when altering the height of the car and applying wheels at the same time on the same end of the car? Only Item 420 specifies jacking. Does Item 101, Rule 101, include jacking? If there is no reduction, then you have a right to charge for jacking of the car with Item 101. If each of the items includes jacking of the car, then there ought to be a reduction when the two are done at the same time.

M. E. Fitzgerald: There is a confliction there. However, the matter is now before the American Railway Association and the matter of jacking is being taken care of.

J. P. Carney (M. C.): I move that this Association recommend to the arbitration committee to raise the percentage on the labor and material—10 per cent on labor and 15 per cent on material.

The motion was seconded and carried.

C. J. Wymer: There is something in Rule 36 relative to applying missing placards. It says, "Application or removal of such placards or certificates should be charged for on authority of defect card in accordance with Rule 107." Rule 107 does not provide an item for the application of placards. It is all removal. I move that another item be added in there providing a charge for the application of such cards as required by Rule 36.

The motion was seconded and carried.

Rule 111

Mr. Jameson: Rule 111, Item 29: Does the average charge of $4.92 include the material charge for a triple check-valve case, also cylinder piston packing leather expander, J-M type, and triple cylinder applied at the same time that air brakes are cleaned?

M. E. Fitzgerald: May I read an interpretation from the Association: "This average charge covers all labor and material necessary to perform the operation except those items specifically covered in the item itself. No charge is proper for triple valve gasket, either labor or material, when average charge per Item 29 of Rule 111 is made for cleaning brakes."

This is from the secretary of the Association.

Item 29 in Rule 111 clearly defines each operation, both labor and material, and makes no reference whatsoever to the triple valve gasket nor the two or three stud bolts, whichever may be the case, attaching the triple valve to the body of the brake reservoir. Many roads are billing for that item regardless of this interpretation. I move that inasmuch as the items are not properly specified in Rule 111, Item 29, they be considered as billable against the car owner and that also in case of application of J-M. expander, the additional material cost over the ordinary rate be also billable.

The motion was seconded.

Mr. Jameson: Do I understand that to include the triple valve check case and the triple valve cap? The interpretation simply said that the exceptions were all shown. What are the exceptions exclusive of the renewal of the triple valve body? I asked an air brake foreman what a triple valve body was and he told me that it was the cylinder in which the triple piston moves. To make a complete triple valve requires the check case and the cap.

M. E. Fitzgerald: I would not include in my motion any of the parts specified such as check case or front cap. In arriving at the average cost of material and labor necessary in repairing a triple valve, the committee got statements from various roads, showing just what they used and the average was used as a basic price. It includes those particular items, except the triple valve body and so states in Rule 111, Item 29. I merely wish my motion to cover items that are not strictly associated with the repair of the triple valve or the cleaning of the cylinder. It is not necessary to renew a stud bolt or its nut in cleaning the cylinder, neither is it necessary to renew the triple valve gasket. Neither of the items come with either the cylinder or the triple valve if you purchase them, or if you have them repaired in your air room. The work and labor of handling is performed by different men and those items were not included when the average cost price was arrived at.

The motion was carried.

Mr. Jameson: I move that we should get an additional charge for the check-valve case and triple cap when necessary to renew these parts. I do not believe it was the intention to include them in the item of $4.92, Item 29, Rule 111, because it is an extraordinary case when they are broken. Those parts rarely have to be renewed.

The motion was seconded and carried.

Rule 101

M. E. Fitzgerald: We previously discussed labor charges in connection with nipples and the question was raised as to whether or not the price for nipple included the threading. The item in Rule 101 allows 15 cents for a complete one inch or inch and a quarter nipple. Item 29, Rule 111, allows 18 cents for threading the end of a pipe; in other words, two threads, if cut in your yards, would entitle you to a charge of 36 cents and the nipple is only worth, including the material, 15 cents. One must be wrong.

Mr. Owen: A nipple 12 in. long or less is a manufactured nipple; anything over 12 in. we are making an extra charge for cutting the threads on it. This charge of 18 cents is for a thread cut in the yard with a solid die.

M. E. Fitzgerald: In other words, Mr. Owen has a 13-in. nipple, one inch longer than specified in Rule 101, and charges us seven cents a pound for pipe, 36 cents for the threads and gets twice as much and more for his 13-in. nipple than I can get for a 12-in. nipple. I am not objecting to the 15-cent price on the complete nipple, but if he puts on his 13-in. nipple he is going to get 45 cents for it. That is wrong.

Mr. Owen: The 12-in. nipples, or anything under are always carried in stock as a manufactured article. They are cut up in 100 and 200 lots and the threads are cut on the machine where the others have to be cut by hand.

M. E. Fitzgerald: We buy in the open market nipples as long as 18 in., quoted by various manufacturers. I move that this Association consider the rules deficient with respect to nipples, thread cutting, etc., and refer the matter to the A. R. A. rules committee.

The motion was seconded and carried.

A. S. Sternberg: There seems to be a great deal of confusion among the different railroads in preparing bills due to the fact that so few of them get the interpretations and decisions rendered by this price committee of the A. R. A. I move that, since the interpretations on charges in Rules 101, 107 and 111 are rendered by the A. R. A. price committee, we ask that a copy of such decisions and interpretations be mailed to the car departments and representatives of the various railroad companies to enable all concerns to adopt a uniform method of charging and avoid misinterpretations and unnecessary letter writing.

The motion was seconded and carried.

Rule 112

F. H. Hanson: What is meant by that word "Hopper" in the caption at the top of the table in Rule 112, page 157?

C. J. Wymer: I took that up with Mr. Hawthorne and he said it was an error. He said that the word "Hopper" should be in the column with box car.

M. E. Fitzgerald: On page 161, Rule 112, article (d) refers to rebuilt cars. This rule has been in the book for a year and when the Rules Committee made paragraph (d) and referred it to the Association they followed it by requesting or advising that the Committee on Car Construction would provide standard requirements for the rebuilt car. Such standards have never been submitted. We do not know what is a standard requirement for the rebuilt car and we cannot find out from anybody. I move that this Association call to the attention of the Arbitration Committee the fact that we have not received information as to what constitute the strength requirements for a rebuilt car and that they be incorporated in the new rules.

The motion was seconded.

P. M. Kilroy: The Committee on Car Construction has reported recently and their report has been confirmed by letter ballot. That report specifies a draft gear, not of any particular type; it specifies steel ends, it specifies 30 sq. in. of cross section area at bolster instead of 24 sq. in., and a lot of other things. It also provided that when cars went into the shop and required an entire end, that the end should be replaced with either an all steel end or one meeting the requirements as recommended by the committee. That provision failed to pass. All other items, I believe, as reported by the Committee on Car Construction passed and are now in effect.

M. E. Fitzgerald: My motion is still in order inasmuch as we have not gotten any report and they have not complied with the recommendations of the committee.

The motion was carried.

E. Head (Wabash): In the settlement for a car the records cover the age of a car and everything else and the record light weight of the car should have some weight in the matter of settlement. The rule says "Stenciled light weight." We find that the stenciled light weight differs from the record. Just how should we settle that?

A. Kipp: I do not see why his record should not agree with the stenciled light weight.

E. Head: You have not got the same weight on the record that is on your car always. There are cars going around the country without any light weight on them.

A. S. Sternberg: As Mr. Head said, if a car is burned up or destroyed by fire or smashed up in a wreck, you cannot get the light weight; you have to ask the owner for it. His point is that the owner of the destroyed car should be asked to furnish the light weight the same as he is asked to furnish the age of the car.

Rule 120

M. W. Halbert (Chief Inspector, St. Louis, Mo.): The St. Louis Car Foremen's Association recommends that Rule 120 be changed to read as follows:

House and Stock Cars:	
Wooden, with trucks of 60,000 lb. capacity and over, if equipped with metal draft arms extending beyond body bolster, continuous metal draft arms, transom draft gear, metal center sills..........	$225.00
All steel, *steel underframe*, or steel superstructure frame with steel underframe....................................	315.00
Gondola and Hopper Cars:	
Wooden, with trucks of 60.000 lb. capacity and over, if equipped with metal draft arms extending beyond body bolster, continuous metal draft arms, transom draft gear, metal center sills..........	180.00
All steel, *steel underframe*, or steel superstructure frame with steel underframe	270.00
Flat Cars:	
Wooden, with trucks of 60.000 lb. capacity or over, if equipped with metal draft arms, extending beyond body bolster, continuous metal draft arms, transom draft gear, metal center sills..........	108.00
Steel underframe..	150.00

It is felt that the present rules do not allow enough for making repairs to steel underframe cars.

Secretary Elliott: We want to take "steel underframes" out of each paragraph referring to wooden equipment and add it to the paragraph dealing with steel construction. We feel that there should be an increase in the amount we are allowed before we have to write the owner. I move that we accept those recommendations.

The motion was seconded and carried.

F. H. Hanson: Rule 120, paragraph (e): We ask the owner for authority to repair or destroy the car. I move that we set a time limit of thirty days. We now have cars on our line that have been there for over a year. We are unable to get even replies to our letters from the owner.

The motion was seconded.

C. J. Wymer: Suppose the owner does not answer in thirty days, what is the penalty?

F. H. Hanson: I would say that if we get no reply from the owners inside of thirty days, destroy the car.

Mr. Fitzgerald: I would say if you receive no answer at the expiration of thirty days that you proceed using your own good judgment. You would not want to maliciously destroy a car because the rule gave you the permission to destroy it if the car was worthy of repairs.

F. H. Hanson: It would be assumed, of course, that we would not destroy a car that should be repaired. I dare say that 75 per cent of the cars that we are writing up should not be repaired; they should go into the scrap pile.

We had one particular case that I recall where there were three cars that belonged to a certain railroad and after eight or nine months they finally sent a representative. He called on the foreman who was located at another point and after talking to the foreman and finding out where these cars were stored and had been for months, he said, "I'll take your record, go back and report accordingly." He took back the record that we had already written in the letter.

Secretary Elliott: We find the same condition. We had a car that we wrote up to the owner and after four months he sent his representative down. The representative looked at the car, went away, and we have not heard from him yet. That was four months ago.

The motion was carried.

M. E. Fitzgerald: Rule 120, paragraph (d) reads: "In no case shall the total charge for actual repairs exceed the estimate by more than $50.00 (exclusive of betterment) unless authorized." After you have quoted to the owner the full details and he advised you to proceed with repairs he should accept the bill rendered. Prices in the rules are such that it is a difficult matter for some of the car foremen to estimate. If they are low and they exceed $50 in completing repairs, you must reduce your bill accordingly. I do not think for the difference of $10 or $15 in excess of $50, that there should be questions raised. I move that that paragraph be eliminated and on authority of the owner, repair the car at the cost as per the rules, to eliminate considerable useless correspondence.

The motion was seconded.

F. H. Hanson: I had something in mind along the same line. I was figuring on increasing that $50 to at least $100, but if you cut it out, that is better yet.

The motion was carried.

Chairman Gainey: While it was not the intent of any foreman to mislead the owner of a car written up under Rule 120, still they do it. Just recently I went out to look at a car, checked it with the foreman, asked him where he had the trouble and he said that he did not know. I told him that according to the foot-note under Rule 43 he must tell me how all of this damage occurred when there were more than five broken sills. If you go into the office where the general car foreman is, he looks his records up and cannot find anything on the car. You ask him for his wrecking reports, you run down those wrecking reports and find where this car has been in an accident and should not have been reported under Rule 120.

When you are writing up a car under Rule 120, be sure that you are right and do not mix your wrecked cars with those under this rule.

M. E. Fitzgerald: Your remarks suggest that a paragraph should be added to Rule 120 referring to the statement which should be furnished under Rule 43. There is no reference there, but Rule 43 refers to Rule 120. I move that a paragraph be added referring to that statement.

The motion was seconded and carried.

Division of the Book of Rules

Chairman Gainey: This Association ought to go on record as recommending to the Arbitration Committee that we have two books of rules, one for the interchange of cars and one for the billing and work done in shops on cars.

A motion to divide the book of rules was made and seconded.

A. Herbster: That raises a question in my mind as to the practice on all roads. On the road that I represent, the inspectors make out the billing and repair card; therefore, they all have to have that same information. They also have the cars destroyed in their territory and have to have that information.

C. J. Wymer: I believe we ought to be confined to one book, but I think it would be well to have it arranged in two sections. *The motion was put to a vote and carried.*

Passenger Car Rules

Rule 8

F. H. Hanson: I move the elimination from Rule 8, Section (e), the words "Cut journal." That is on page 217.

The motion was seconded and carried.

Mr. Jameson: I think when we cut out the cut journals we just did half the work. I move that the slid-flat wheels also be eliminated from Rule 8.

The motion was seconded and carried.

Rule 22

A. Armstrong (Atlanta, Ga.): Item 52, Rule 22. Page 232, gives the value of a new 36 in. wrought steel wheel as $65.84, Scrap, $8.00. If these figures are correct, shouldn't the value of the service metal per 1/16 in. as shown in Item 47, page 231, of the same rule, be $2.41 instead of $2.47? No doubt the bill clerks have caught that.

C. C. Stone: Twenty-four sixteenths at $2.47 amounts to $67.28. Mr. Armstrong wants to know if there isn't an error in the price of the service metal. It should be $2.41 instead of $2.47. There is six cents difference there somewhere.

The meeting adjourned.

Insulation of Freight and Passenger Cars

Theoretical and Practical Considerations; Values of Various Materials; Calculating Heat Transmission

BY WM. N. ALLMAN

The insulation of heated surfaces in power plants and on locomotives has now become recognized as extremely important on account of the conservation of fuel. In this article, however, another phase of insulation is discussed, namely, that pertaining to the roof and walls of refrigerator and steel passenger cars, each of which will be taken up separately.

It may be said in general that if two adjacent bodies have different temperatures, there is a tendency for one to affect the other, or in other words an average temperature will result. This condition may be brought about by either of the three methods of conveyance, namely, radiation, convection or conduction. These are the methods of heat transfer that must be dealt with in the consideration of the proper form of insulation in the walls of railway equipment cars.

Insulating Material

The study of heat transmission has been given considerable thought in recent years and investigations have been made in order to determine the co-efficients of heat transmission of various insulators. In the application of these co-efficients it is necessary to consider the outside temperature of the air and also the temperature within the car.

In choosing an insulating material, the fact should not be overlooked that it is the most vulnerable part of the construction of the car. Further it must be capable of withstanding deterioration or rotting, and in addition should be free from odors and be vermin proof. Unless it is correctly applied it is very liable to break away after the car has been in service a while, and settle, leaving pockets and air spaces which result in greatly reducing the efficiency of the insulation. Another important feature is that the insulation should be waterproof so that moisture will not collect, thus tending to diminish its ability to insulate.

Theory of Insulation

A heat insulator or non-conductor is a material which by its structure retards or obstructs the transfer of heat. According to this theory there is no material that resists heat perfectly. In recent years, the matter of insulation has been given particular study, and it is now generally agreed that the best insulating value is obtained in a solid form consisting of a large number of interstices or dead air cells, rather than alternating solid layers (without air cells) and air spaces. Formerly the opposite opinion was generally held. However, later experience has taught that the so-called air space construction is seldom built with the care which must be exercised to make such spaces air-tight, and if such spaces have communication with each other, permitting a circulation of air, the real purpose is destroyed by circulation or convection and the efficiency lost. There exist great differences of opinion on this subject of insulation. Jean Claude Peclet in his famous treatise on heat "Traite de la Chaleur" nearly a century ago made some searching experiments on the subject of insulation, and since that time numerous investigations have been made. Notwithstanding, the whole subject is still open to debate. Even the most casual observer can very readily observe the great differences in opinion and in the results obtained, due entirely to the different methods employed in the calculations.

Various experimenters have derived widely different results in their tests on the same type of material and especially in their results for compound walls. Some have not allowed any value for air spaces or for surface resistance, and when these values are omitted, especially on thin combinations, the value given for the section varies greatly. We are therefore face to face with the question as to which method or authority should be accepted as correct.

During the past few years studies and investigations have been made by numerous engineers. In the writer's opinion there is no further room for doubt and the results, as submitted in treatises by H. C. Dickinson and M. S. Van Dusen, of the National Bureau of Standards, may be accepted as correct.

The question of surface resistance (also referred to as "contact resistance" and "skin effect" by some writers) is being recognized as a most important factor recently, although neglected by some of the authorities on heat transmission. In the following analysis both surface resistance and the value of air spaces are taken into consideration, as this is now generally accepted as being correct.

TABLE I.—VARIATION OF HEAT TRANSMISSION WITH AIR VELOCITY

Air Velocity, Ft. Per Min.	B.t.u. Per Hr. Per Sq. Ft. Per Deg. F. Diff.
222	0.130
298	0.133
437	0.137
800	0.159
898	0.169
900	0.170
905	0.170

While it is impossible to prevent entirely the passage of heat through cold storage walls, yet it has been proved that certain forms of construction retard the progress of heat much more than others. A perfect vacuum would be the ideal insulator; this condition, however, does not exist in practice, so the next best arrangement is to provide for still air, or "dead air spaces." Free air is never still, but moves as its density is changed either by a loss or gain in heat, or moisture, or both. In order to secure motionless air, it must therefore be confined, so as to prevent circulation, and in order to provide for this the insulation must be divided into the smallest possible particles and stored in minute cells.

Heat Conductivity of Insulators

A good insulator must be primarily a good non-conductor, since its chief function is to prevent the flow of heat as much as possible. It must also be capable of withstanding relatively high temperatures without calcining and retain its structural strength in the presence of moisture.

Prof. J. A. Moyer, of the Pennsylvania State College, in tests found that heat transmission varied with the air velocity over the outside of the surface. The results of these tests, made with a corkboard cube, are shown in Table I.

These tests show that the transmission is increased about 34 per cent as the velocity of the air is varied from 222 ft. per min. to 905 ft. per min., or in other words the transmission is changed 5 per cent per 100 ft. per min. change in velocity. From this it will be noted, particularly in railway service, that speed increases the heat transmission consider-

TABLE II—THERMAL CONDUCTIVITIES

Line No.	Material	Thermal Conductivity		Density		Remarks
		$K \times 10^5$	k	D	d	
1	Asbestos wood	93.0	65.0	1.97	123.0	Asbestos and cement
2	Asbestos paper	17.0	12.0	0.50	31.0	Built up thin layers
3	Balsa wood	10.7	7.5	0.113	7.1	Very light wood, across grain
4	Balsa wood	11.9	8.3	0.128	8.0	Same sample with 13% waterproofing com'pd
5	Balsa wood	11.9	8.3	0.118	7.4	Across grain—untreated
6	Balsa wood	13.2	9.2	0.14	8.8	Medium weight wood
7	Balsa wood	20.0	14.0	0.33	20.0	Heavy
8	Burrash	11.6	8.1	0.14	8.8	Confined with cloth
9	Asbestos mill-board	29.0	20.0	0.97	61.0	
10	Asphalt roofing	24.0	17.0	0.88	55.0	Felt saturated with asphalt
11	Air cell half inch	15.0	11.0	0.14	8.8	Corrugated asbestos paper—enclosing air spaces
12	Air cell 1 inch	17.0	12.0	0.14	8.8	Corrugated asbestos paper—enclosing air spaces
13	Cork-board	9.3	6.5	0.11	6.9	No artificial binder, low density
14	Cork-board	10.4	7.3	0.16	9.9	No artificial binder.
15	Cork-board	10.6	7.4	0.18	11.3	No artificial binder
16	Cork-board	12.1	8.4	0.25	16.0	With bituminous binder
17	Cotton seed—hull fiber	10.8	7.5	0.071	4.4	Loosely packed
18	Cabots quilt (eel grass)	11.0	7.7	0.25	16.0	Enclosed in burlap
19	Ceiba wood	11.3	7.9	0.113	7.1	Across grain—untreated
20	Cypress	23.0	16.0	0.46	29.0	Across grain
21	Cotton wool	10.0	7.0	0.08	5.0	Medium packed.
22	Flaxlinum	11.3	7.9	0.18	11.0	Felted vegetable fibers
23	Fibro felt	11.3	7.9	0.18	11.0	Felted vegetable fibers
24	Fire felt sheet	21.0	14.0	0.42	26.0	Asbestos sheet coated with cement
25	Fire felt roll	22.0	15.0	0.68	43.0	Flexible asbestos sheet
26	Gypsum plaster	80.0	56.0	0.74	46.0	
27	Ground cork	10.2	7.1	0.15	9.4	Less than 1-16 in.
28	Hair felt	8.5	5.9	0.27	17.0	Fibers, perpendicular to heat flow
29	Insulex	19.0	13.5	0.29	18.0	Asbestos and plaster blocks, very porous
30	Insulite	10.2	7.1	0.19	12.0	Pressed wood pulp
31	Keystone hair felt	9.3	6.5	0.30	19.0	Hair felt between waterproof paper
32	Kapok	8.2	5.7	0.014	0.88	Hollow vegetable fibers
33	Lithboard	13.1	9.1	0.20	12.5	Mineral wool, vegetable fibers and binder
34	Linofelt	10.3	7.2	0.18	11.3	Vegetable fibers confined with paper
35	Magnesia—85%	17.5	12.0	0.31	19.0	Magnesia and asbestos
36	Mineral wool	9.3	6.5	0.20	12.0	Loosely packed
37	Mineral wool	9.9	6.9	0.29	18.0	Fibers perpendicular to heat flow
38	Mineral wool	10.2	7.1	0.34	21.0	Firmly packed
39	Mahogany	31.0	22.0	0.55	34.0	Across grain
40	Pure wool	8.4	5.9	0.11	6.9	
41	Pure wool	8.4	5.9	0.10	6.3	
42	Pure wool	9.0	6.3	0.08	5.0	
43	Pure wool	10.1	7.0	0.04	2.5	Very loose packing
44	Oak	35.0	24.0	0.61	38.0	Across grain
45	Planer shavings	14.0	10.0	0.14	8.8	Various.
46	Paraffine	55.0	38.0	0.89	56.0	"Parawax," melting point, 52° C.
47	Rock cork	11.3	7.9	0.25	16.0	Mineral wool and binder
48	Regranulated cork	10.7	7.5	0.13	8.1	About $\frac{3}{16}$ inch
49	Rubber	42.0	29.0	1.1	69.0	Soft vulcanized
50	Slag wool	9.0	6.3	0.20	12.0	Loosely packed
51	Sil-O-Cel	10.6	7.4	0.17	10.6	Pulverized
52	Sil-O-Cel	20.0	14.0	0.45	28.0	Infusorial earth, natural blocks
53	Sil-O-Cel	21.4	15.0	0.50	31.0	Infusorial earth, natural blocks
54	Saw dust	14.0	9.7	0.19	12.0	Various
55	Sole leather	38.0	26.0	1.00	62.0	
56	Textan	40.0	28.0	1.3	81.0	Rubber composition
57	Virginia pine	33.0	23.0	0.55	34.0	Across grain
58	Wood felt	12.5	8.7	0.33	21.0	Flexible paper stock
59	Wall board	17.0	12.0	0.69	43.0	Stiff pasteboard
60	White pine	27.0	19.0	0.50	32.0	Across grain
61	White celluloid	50.0	35.0	1.4	88.0	
62	Zenitherm	17.0	12.0	0.26	16.0	Infusorial earth and asbestos.

K = Thermal conductivity in calories per sec., per sq. cm., per degree C., per cm. thickness.
k = Thermal conductivity in B. t. u. per day (24 hrs.) per sq. ft. per degree F., per inch thickness = 69700 × K.
D = Density in grams per cu. cm.
d = Density in lb. per cu. ft. = 62.5 × D.

ably, which should not be overlooked when providing for the proper insulation and B.t.u. losses.

Early Investigations

All investigators have profited by the experiments of Peclet, who was the pioneer in the field. His work was followed by investigations under the direction of the German Government conducted by Herman Iman Rietschel and Franz Grashof. The results of these tests have been translated by John Henry Kinealy and published in 1899 as "Formulas and Tables for Heating." These results still form the fundamental basis for many transmission co-efficients in use at the present time.

Examples and Application of Formulas

As is well known, the transfer of heat can take place by either conduction, radiation or convection. There is quite a variation in the terms applied to the subject of insulation, and in many cases the subject has become very confusing. The following definitions of the terms used in this article are therefore given:

1. *Temperature Gradient*—Temperature difference per unit distance.
2. *Thermal Conductivity*—Time rate of heat flow per unit area per unit temperature gradient.
3. *Thermal Conduction*—Time rate of heat flow per unit area per unit difference in temperature between opposite faces of a slab when the direction of heat flow is assumed to be perpendicular to the faces of the slab.
4. *Thermal Resistance*—The reciprocal of conduction.
5. *Transmission*—Rate of heat flow per unit area per unit temperature difference between the medium on one side of a wall and the medium on the other (the temperatures are assumed to be measured far enough from the material so that the effect of the latter will be unappreciable).
6. *Surface Transmission*—Rate of heat transfer between a surface and the surrounding air, per unit area and unit temperature difference between the surface and the air.

The principal difficulty in all tests for conductivity has been the varying results due to the different methods employed in conducting such tests. In the writer's opinion the results given by M. S. Van Dusen and presented in the October, 1920, issue of the Journal of the American Society of Heating and Ventilating Engineers can be generally accepted as an accurate basis for determining heat transmission. These values are shown in Table II. In this table are included only those materials that would ordinarily be considered in freight and passenger car equipment.

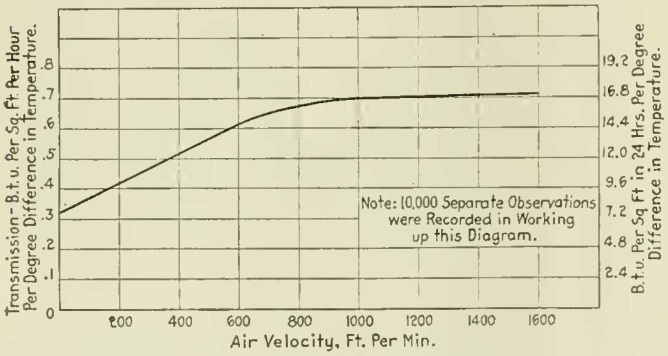


Fig. 1—Heat Transmission of Steel Car Section as Influenced by Air Velocity

Increase up to 700-ft. almost uniform at rate of .0457 B. t. u. for each increase of 100-ft. per minute, or 14% for each 100-ft. per minute increase. Note almost constant increase for velocities 1,000 to 1,600-ft. per minute.

In the treatment of this subject it has been common recently to refer to the transmission in resistance units instead of conductivity. One unit, however, is the reciprocal of the other, therefore the term "Thermal Resistance" will be adhered to in this discussion. In the analysis of heat transmission it is also necessary to consider that velocity greatly increases the transmission and that another factor is to be considered, namely, surface resistance.

As regards the effect of velocity on transmission of heat Arthur J. Wood has also made some very exhaustive tests in his study on heat transmission with a steel car section. The extent of this investigation may be gathered from the statement that over 10,000 separate observations were recorded and worked up in determining the curve in Fig. 1. It will be seen that the transmission increases almost uniformly up to a velocity of 700 ft. per min. at the rate of .0457 B.t.u. per 100 ft. increase in velocity, or about 14 per cent for each 100 ft. increase per minute.

The matter of surface resistance or transmission is still debatable, but for all practical purposes it is safe to assume a conductivity of 2 B.t.u. per sq. ft. as fairly correct, or in other words a resistance equal to .5, this being the reciprocal of conductivity.

The next question of importance is the subject of air spaces and the value assigned to such. In Table III are given the results of tests made by the U. S. Bureau of Standards, and it is considered that 1 B.t.u. per hour per sq. ft. is practically correct for air spaces in car equipment.

In referring to the theory of the laws governing heat transmission it may be stated that the law of conduction is analogous to Ohm's law for the conduction of electricity. Ohm's law is expressed as follows:

$$I = \frac{E}{R} \qquad (1)$$

or

$$I = EC \qquad (2)$$

where I = Strength of current in amperes
E = Electromotive force or potential difference
C = Conduction of the circuit = $\frac{1}{R}$ or the reciprocal of resistance.
R = Resistance

From the above we then derive:

$$\frac{1}{\text{Resistance}} = \text{current per unit potential difference.} \qquad (3)$$

The rate of heat flow through a surface wall or a compound wall may be determined by the following formulas:

For a single wall:

$$H = \frac{T_1 - T_2}{\frac{1}{K} + \frac{d}{C}} \qquad (4)$$

For a compound wall:

$$H = \frac{T_1 - T_2}{\frac{1}{K} + \frac{d}{c} + \frac{d_1}{c_1} + \frac{d_2}{c_2} + \text{etc.}} \qquad (5)$$

where
H = Heat in B.t.u. transmitted per sq. ft. per hour
T_1 = Inside temperature
T_2 = Outside temperature
$\frac{1}{K}$ = Surface resistance = 0.5
d, d_1, d_2, etc. = Thickness of each element in wall
c, c_1, c_2, etc. = Thermal conductivity of elements corresponding to thicknesses d, d_1, d_2, etc., per inch thickness.

In other words the thermal resistance is the reciprocal of conduction and is equal to the thickness of the material divided by the conductivity. After obtaining the sum of all resistances entering into the section the heat transmitted in B.t.u. will be equal to 1 divided by the total resistance. This result in turn will be equal to the total B.t.u. transmitted per sq. ft. per hour per deg. F.

Surface resistance is not so much of a factor in extremely thick walls of great insulating value, but with thin insulation or none at all surface resistance becomes very important as will be observed from the results obtained in substituting the various values in the formulas.

TABLE III—THERMAL CONDUCTION IN VERTICAL AIR SPACES 8 IN. HIGH

Width of spaces, in.	Temp. diff. 18 deg. F.		Temp. diff. 27 deg. F.		Temp. diff. 36 deg. F.		Temp. diff. 45 deg. F.	
	C	K	C	K	C	K	C	K
.125	50	6.3	51	6.4	52	6.5	53	6.6
.25	32	8.1	33	8.2	33	8.3	34	8.5
.375	26	9.8	27	10.0	27	10.2	28	10.4
.5	23	11.6	24	11.9	24	12.2	25	12.5
.625	22	13.6	23	14.2	24	14.8	25	15.5
.75	22	16.4	23	17.4	25	18.4	26	19.3
.875	22	20.0	24	21.0	25	22.0	26	23.0
1.0	22	22.0	24	24.0	25	25.0	26	26.0
AIR SPACES 24 IN. HIGH								
.5	22.0	11.0	23.0	11.5	23	11.5	24	12.0
1.0	19.1	19.1	20.0	20.0	22	22.0	23	23.0
2.0	18.4	37.0	19.9	40.0	21	43.0	23	46.0
3.0	18.7	56.0	19.7	59.1	21	62.0	22	66.0

C = B.t.u. per 24 hrs. per ft. per deg. F. per inch thickness.
K = B.t.u. per 24 hrs. per ft. per deg. F. for the thickness give in first column.

We have previously mentioned that the transfer of heat takes place by conduction, radiation or convection. The conductivity of the different elements is readily obtained from various tables of insulation conductivities but on account of the lack of definite data concerning the other two factors, radiation and convection, they have been generally combined into the one co-efficient of "Surface Transmission" in heat transfer calculations.

For investigations of temperature gradients and other calculations involving the passage of heat the use of heat resistance units should appeal to the modern engineer as in the writer's opinion engineers are more familiar with and recognize these terms.

Insulating Steel Passenger Cars

In insulating steel passenger cars the fact should not be overlooked that the function of an insulator is to keep the car cool in summer and prevent the loss of heat in the winter.

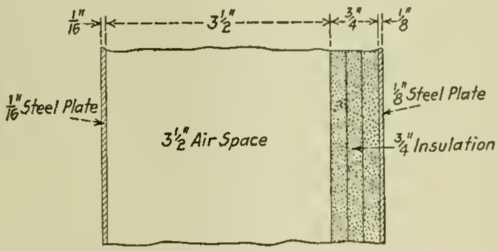


Fig. 2—Representative Section of Steel Passenger Car Wall

Sound deadening is also another important feature as well as the adaptability and permanence of the construction.

The Post Office Department has issued standard specifications for the construction of steel postal cars and under "insulation" is found the following requirement:

> The thermal efficiency of the materials in side and end walls, in roof and in floor must be such that a test duplicate section through walls, roof, or floor (duplicate with the exception of framing members, such as posts, braces, carlines, or stringers, which are to be omitted) will not transmit, when subjected to the test hereinafter described, more than the following amount of heat per sq. ft. or surface in 24 hours for each degree F. difference in temperature between the inside and outside walls of the section.
>
> | | |
> |---|---|
> | For side walls, end walls and roof........ | 8 B.t.u. |
> | For floor .... | 7 B.t.u. |

In some calculations, due to the small insulating value of the steel plates, these elements have been ignored. In this case, however, the inside and outside steel plates will not be disregarded. The value will be based on a conductivity of 322 B.t.u. per sq. ft. per hour per degree F. per inch thickness.

From formula 5 the following formula, No. 6, is derived when the B.t.u. heat transmission or thermal conductivity is desired for a difference of one degree in temperature.

$$H = \frac{1}{\frac{1}{K} + \frac{d}{c} + \frac{d_1}{c_1} + \frac{d_2}{c_2} + \text{etc.}} \qquad (6)$$

The thermal resistance *R* will therefore equal the reciprocal of conduction, or

$$R = \frac{1}{H} \qquad (7)$$

In the car section under consideration, shown in Fig. 2, we will assume the outer plate to be 1/8 in. thick and the inner plate 1/16 in. thick, with three-ply Salamander insulation representing a normal thickness of 3/4 in. The value of insulation efficiencies for various insulating materials such as are used in railway equipment cars is shown in Table IV. These figures are the results of tests made by the Union Pacific at Omaha, Neb., in 1914 for the Standard Car Committee. In referring to this table it will be observed that the value assigned to 3/4 in. Salamander is 6.576 B.t.u. per sq. ft. per degree F. difference in temperature per 24 hours or .274 B.t.u. per hour. In view of the fact that the conductivity varies inversely as its thickness the B.t.u. transmission for the unit thickness of 1 in. will be:

$$.274 : X :: 3/4 = .2055 \text{ B.t.u.}$$

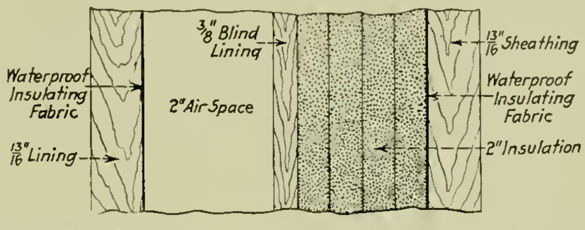


Fig. 3—Representative Section of Side Wall of Refrigerator Car

Applying the foregoing values to the car section shown in Fig. 2 we have the following:

1/16 in. and 1/8 in. steel plates....	322 B.t.u.
3 1/2 in. Air space (Resistance)...	1 B.t.u.
3/4 in. Salamander	.2055 B.t.u.
Surface resistance	.5 B.t.u.

Substituting in formula 6 we then have:

$$H = \frac{1}{.5 + \frac{.125}{322} + \frac{.75}{.2055} + 1 + \frac{.0625}{322}} =$$

$$\frac{1}{.5 + .000388 + 3.65 + 1 + .000194} = .194 \text{ B.t.u. per hr.}$$

For this typical section this would mean a total of 4.656 B.t.u. transmitted for 24 hours, which is well within the figure of 8 B.t.u., as specified in the Post Office Department specifications as the maximum transmission.

Insulating Refrigerator Cars

The correct insulating of refrigerator cars has been given much thought in recent years, and the subject of insulating efficiencies has naturally been investigated in order to arrive at a definite program for refrigerator car sections. There are a few features which should receive consideration, namely, weight, absorption of moisture, and the adaptability and permanence of the insulation. The importance of a good insulation is therefore well understood, and the first and most important matter of thermal conductivity of the walls should not be overlooked. During the regime of the Railroad Administration the mechanical department developed a design of car which provides for 2 in. of insulation in sides and ends, 2½ in. in the roof and 2 in. in the floor. In analyzing a representative section we have chosen as an example the side wall of the U.S.R.A. refrigerator car as shown in Fig. 3.

Applying formula 7 and using the following values as shown in Table II, the B.t.u. transmission can be obtained.

13/16 in. Sheathing and lining	1 B.t.u. per hr.
2 in. Insulation (basis 4 layers ½ in. Keystone)	.271 B.t.u. per hr.
⅜ in. Blind lining	1 B.t.u. per hr
2 in. Air space	1 B.t.u. per hr.

Therefore

$$H = \frac{1}{.5 + \frac{.8125}{1} + \frac{2}{.271} + \frac{.375}{1} + 1 + \frac{.8125}{1}} =$$

$$\frac{1}{.5 + .8125 + 7.4 + .375 + 1 + .8125} = \frac{1}{10.9} = .0918$$

B.t.u. per hr.

or $.0918 \times 24 = 2.203$ B.t.u. per sq. ft. per Degree F. Diff. per 24 hours.

No value has been given to the two layers of waterproofing fabric as this would have very little effect on the result.

There is one point in the construction of the walls of a refrigerator car to which too much value should not be assigned, namely, air spaces. Experience of recent years brings out the fact that it is practically impossible to construct a car with an absolute dead air space, that will remain so, on account of the peculiar stresses and strains to which refrigerator cars are subjected. The real secret of good insulation, therefore, is to adopt a homogeneous insulation containing a large number of enclosed, minute air cells. It should also be understood that the transmission rates arrived at above are for still air conditions and would be greatly increased according to velocity as referred to in the beginning of this article.

Care of Pipe Threading Tools.—In order that pipe tools should do the work required of them, they should be made in a manner to assure easy cutting. The lands should be relieved in the thread, as the thread is cut on a taper, and necessarily there must be a large amount of friction. Only by relieving the cutters in the thread can excessive friction be avoided.

When a pipe tap begins to cut hard and tear the thread it is evidence that it is dull and needs grinding. This can be done by the use of an emery wheel of the proper thickness and form of face, grinding the tap in the flute until the cutting edge shows a perfect form. Care should be exercised not to heat the points of the teeth enough to soften them. In the case of 2½-in. and larger taps having inserted lands, the lands can be taken out and all ground to a uniform thickness and replaced. This will assure a uniform cut on each land. When the blades have been ground back so they are no longer safe to use they can be replaced by new blades, as the center is so made that the sets of blades will register and cut perfect threads.

After grinding, all pipe taps should be rechamfered so they will start to cut uniformly.

To keep an ordinary pipe die in good shape is more difficult owing to its form, but not a particle less necessary, as a dull or damaged die will tear the thread on the pipe and cause leaks. The proper way to sharpen a die is to use a small emery wheel or emery stick running at high speed and touch up the cutting edge and chamfer of the die. A die with removable lands can be ground by taking the lands out of the head, grinding the cutting edge and chamfer and replacing them. A receding pipe threader should be used for all pipe 2 in. and larger. Then the chasers can be easily ground and kept in good shape.

The frequency with which taps and dies require regrinding and hence their length of life, is largely dependent upon the use of a suitable cutting compound. A good grade of lard oil is recommended as giving the most satisfactory results. Never use mineral oil as a cutting compound. Rather than use mineral oil, use water or cut with a dry tool.

The usual precautions observed by any good mechanic in the use and care of his tools apply with equal force to taps and dies. Do not throw them around. It will injure the cutting edges. Clean and oil them before you put them away to avoid rust. Keep the flutes clear of chips. Your care will be rewarded by longer life of the tools and greater satisfaction in their performance—*Helix, G. T. & D. Co.*

TABLE IV—INSULATION EFFICIENCIES—TESTS MADE BY UNION PACIFIC FOR STANDARD CAR COMMITTEE, 1914

Name of Insulation	Manufacturer	Thickness in inches	Weight per sq. ft.	Moisture absorbed per cent	Vol. of gas evolved per gram	B. T. U. per sq. ft. per deg. Fahr. diff. in temp. per 24 hrs.	Relative combustibility
Agasote	Pantasote Co.	3/16"	13.58	6.63	137	16.344	Combustible slowly, but will not spread fire
Agasote	Pantasote Co.	¼"	16.87	11.29	....	16.632	Combustible slowly, but will not spread fire
Headlining	Keyes Products	¼"	14.98	8.85	125	15.816	Combustible slowly, but will not spread fire
Headlining	Keyes Products	31/32	19.50	7.91	....	14.32S	Combustible slowly, but will not spread fire
Nonpareil Cork Board	Armstrong Cork Co.	¼"	4.43	3.63	175	13.344	Combustible slowly, but will not spread fire
Nonpareil Cork Board	Armstrong Cork Co.	½"	8.45	3.27	....	10.368	Combustible slowly, but will not spread fire
Nonpareil Cork Board	Armstrong Cork Co.	1"	14.98	3.22	....	6.576	Combustible slowly, but will not spread fire
Nonpareil Cork Board	Armstrong Cork Co.	2"	27.97	2.44	....	4.224	Combustible slowly, but will not spread fire
Nonpareil High Pres. Lagging	Armstrong Cork Co.	1"	23.77	9.26	Non-Comb.	8.448	Non-combustible
Nonpareil High Pres. Lagging	Armstrong Cork Co.	2"	46.45	10.54	Non-Comb.	5.448	Non-combustible
Magnesite	Pullman Co.	1"	32.41	20.62	....	9.24	Non-combustible
Carline	Franklin Mfg. Co.	⅛"	7.04	4.28	....	16.392	Non-combustible
Carline	Franklin Mfg. Co.	3/16"	8.83	4.85	....	16.32	Non-combustible
Carline	Franklin Mfg. Co.	¼"	9.98	4.84	....	14.448	Non-combustible
Carline	Franklin Mfg. Co.	⅜"	20.42	3.88	....	13.560	Non-combustible
Carline	Franklin Mfg. Co.	½"	23.00	4.34	....	12.192	Non-combustible
Ceilinite	H. W. Johns-Manville	¼"	12.82	6.49	....	15.912	Non-combustible
Asb. Mill Board	Stock	⅛"	11.78	3.72	....	22.392	Non-combustible
Asb. Mill Board	Stock	3/16"	17.30	2.98	....	15.96	Non-combustible
Asb. Mill Board	Stock	¼"	22.87	2.59	....	18.384	Non-combustible
Single Resisto	Gen'l Ry. Supply Co.	¼"	8.10	21.90	....	14.736	Difficult to ignite, but will not spread fire
Double Resisto	Gen'l Ry. Supply Co.	½"	15.44	22.31	....	10.728	Difficult to ignite, but will not spread fire
Nycinsul	H. W. Johns-Manville	¼"	12.52	8.08	70	12.864	Difficult to ignite, but will not spread fire
Nycinsul	H. W. Johns-Manville	½"	13.11	10.75	....	9.52	Difficult to ignite, but will not spread fire
2-Ply Salamander	H. W. Johns-Manville	½"	7.78	8.57	....	7.968	Difficult to ignite, but will not spread fire
3-Ply Salamander	H. W. Johns-Manville	¾"	10.76	8.56	....	6.576	Difficult to ignite, but will not spread fire
Hair Felt	H. W. Johns-Manville	1"	10.53	17.25	....	6.024	Difficult to ignite, but will not spread fire
Steel Car Linofelt No. 1	Union Fibre Co.	1"	17.87	8.37	197	5.04	Easily ignited, and burns readily
Steel Car Linofelt No. 2	Union Fibre Co.	¾"	14.22	6.18	....	6.60	Easily ignited, and burns readily
Steel Car Linofelt No. 3	Union Fibre Co.	¾"	15.90	4.35	....	6.768	Easily ignited, and burns readily
Cabots Quilt No. 1	Sam'l Cabot	⅝"	8.67	28.18	240	7.584	Combustible, but will not spread fire
Cabots Quilt No. 2	Sam'l Cabot	½"	12.47	20.06	....	8.352	Combustible, but will not spread fire
Cabots Quilt No. 3	Sam'l Cabot	⅝"	10.56	24.00	....	7.824	Combustible, but will not spread fire
Flaxlinum	Northern Insul. Co.	¾"	17.05	15.87	187	7.392	Smolders, but will not spread fire
Fireproof Linofelt	Union Fibre Co.	¾"	18.71	9.33	195	7.344	Smolders, but will not spread fire
Fireproof Fibrofelt	Union Fibre Co.	1"	14.83	4.30	95	9.00	Partially combustible, but will not spread fire
Waterproof Lith	Union Fibre Co.	1"	24.50	5.57	190	7.368	Partially combustible, but will not spread fire
Waterproof Lith	Union Fibre Co.	2"	40.39	6.78	....	5.04	Partially combustible, but will not spread fire
Thermo Jacket	Ehret Mfg. Co.	3/16"	12.44	....	....	14.11	Burns
Angora Jacket	Ehret Mfg. Co.	1"	12.73	....	....	7.73	Readily combustible
85% Magnesia	Stock	1"	25.53	....	....	7.94	Non-combustible
Wallbestos	Ehret Mfg. Co.	½"	43.5	....	....	11.02	Fire resisting

Tests of Oxy-Acetylene Blowpipes*

An elaborate series of tests carried out by the Bureau of Standards, Washington, D. C., on commercial apparatus for oxy-acetylene cutting and welding seems to warrant the following statements:

For the Cutting Blowpipes:

That there is today no generally accepted theory for proportioning, for the cutting of metal of various thicknesses, the volume and velocity of the issuing cutting jet, with the result that none of the apparatus submitted to test proved economical for all thicknesses.

That there is for any thickness of metal cut a limiting velocity of exit of the cutting jet at which complete utilization of the oxygen takes place, and a limiting value for the amount of oxygen required to produce a cut.

That an increase in acetylene consumption, or oxygen consumption, or of the velocity of exit of the cutting jet beyond the limiting values does not produce increased efficiency in commensurate ratio.

That a large majority of the blowpipes tested were equipped with excessive preheating flames for the thickness of metal the tip is specified for, and that such excessive-sized flames are disadvantageous both from the standpoint of economy of operation and quality of work performed.

That considerable improvement in economy of operation seems possible in cutting material of 2 in. thickness and that possibly this condition may be found to exist for metal of other thicknesses than those used in the tests.

That the maximum thickness of metal that may be economically cut with an oxy-acetylene blowpipe of standard design when neither the material nor the oxygen is preheated and the cutting is done only from one direction, is about 12 in.

That the cutting blowpipes due to their incorrect design are subject to the same "flashback" troubles found in the welding blowpipes.

For the Welding Blowpipes:

That the blowpipes most subject to the so-called phenomena of flashback are those in which the oxygen is delivered at a pressure in excess of that at which the acetylene is delivered.

That all the blowpipes tested, including those in which the acetylene is delivered at an excess pressure as well as the so-called equal—or balance—pressure blowpipes, are subject to flashback phenomena on account of inherent defects in their design.

That the cause of the development of the conditions producing flashback is the setting up within the blowpipe tip and head of a back pressure which retards or chokes off the flow of one of the gases.

That this back pressure is the result of confining or restricting the volume flow of the issuing gases at the tip end.

That any cause tending to restrict the flow of the gases sets up a back pressure which immediately causes a change in the amount of each gas delivered to the mixing chamber.

That a fluctuating gas-volume ratio, due to the restriction of volume flow, from whatever cause, prevents a blowpipe from maintaining constantly and at all times during operation the desired "neutral flame."

That a blowpipe that cannot maintain under all operating conditions a neutral flame cannot logically be expected to produce sound welds and is, therefore, unsatisfactory.

That all the blowpipes tested during this investigation either through improper gas pressures or improper interior design or both are incapable of maintaining a neutral flame (constant-volume gas ratio) under all conditions of restricted gas flow and are therefore incapable of producing sound welds where there is any liability of the gaseous products of combustion being momentarily confined such as occurs in practically all welding operations.

That the ability of a blowpipe to consume an equal volume ratio of gases when burning freely and undisturbed in air is no criterion that it is capable of producing sound welds: i. e., that it is not subject to detrimental fluctuations in gas ratio during a welding operation and therefore is

The Foreman and Details

As a foreman how much shoe leather do you wear out in chasing details? Are you studying and managing your department in a big way with a view to getting big results or is your vision being obscured in the effort to adjust numberless details without reference to the problem at large?

How can you dodge an unreasonable amount of detail work? How can these things be made to take care of themselves automatically?

How much time do you spend in cultivating your subordinates and inspiring them to take a greater interest in their work?

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*Summary of results of an investigation presented in a paper by R. S. Johnston, Engineer-Physicist, U. S. Bureau of Standards, before the May 23 to 26 meeting of the American Society of Mechanical Engineers at Chicago.

capable of maintaining a neutral flame under all operating conditions.

That whether a blowpipe of present designs will consume an equal volume ratio of gases when burning freely and undisturbed in air depends on how nearly correct the operator sets the so-called "neutral flame," and experience indicates that the average operator checks the acetylene gas flow too much and actually develops an oxidizing rather than a neutral flame.

That the question of the possible limiting strength and ductility or the efficiency of welds made by the oxy-acetylene welding blowpipe must await the development of a more satisfactory instrument, and that having such an instrument there is no reason to believe that a weld of clean, sound metal cannot be made with assurance during any welding operation and that such welds will or can be made to possess the proper physical properties.

Cost of Air vs. Steam for Operating Hammers*

BY G. H. RICHEY

Sullivan Machinery Co.

The basis of data for figuring the amount of air required to operate steam hammers is obtained from the Chambersburg Engineering Company, Chambersburg, Pa. This company estimates that a steam hammer requires 26 cu. ft. of free air per minute for each 100 lb. of falling weight with the hammer working continuously. Where only one hammer is used in an installation, it is necessary to use the constant, 26, but where three or four or more steam hammers are to be operated from the compressor, 50 per cent of the above figure can be used to determine the size of compressor needed. In the case of steam drop forge hammers, 60 per cent of the constant 26 should be used, because these hammers are usually worked harder than the ordinary steam hammers. The air pressure generally is between 90 and 100 lb. per sq. in.

As an example of the method of determining compressor size for a plant, an installation will be considered where there are two 2,000 lb. and one 1,200 lb. steam drop hammers, making a total of 5,200 lb. falling weight. The actual cubic feet of air which would be required to drive these hammers is obtained thus: $52 \times 26 \times .60 = 811$. A 20-12 by 14 in. angle compound, rolling valve compressor was installed. It runs at 196 r.p.m. to give 1,000 cu. ft. per min. This installation carries the hammers easily with an approximate load factor of 75 per cent. The compressor when operating at 196 r.p.m. against 90 lb. pressure consumes 174 h.p. input to the motor or approximately 130 kw. The plant is working nine hours per day and the electric rate is 1¾ cents per kw. hour.

Comparison With Steam Operation

The cost of compressed air power for one day is obtained as follows:

$$\frac{100}{130 \times .75 \times 9 \times 1\frac{3}{4}}$$ equals \$15.38 using .75 as the load factor. To determine accurately the amount of steam consumed when used directly in the hammers, of course, is quite difficult. At this plant, from four to four and one-half tons of coal a day was used. Assuming four tons, or 8,000 lb. of coal a day, and an evaporation of seven pounds per pound of coal the pounds of steam per minute per 100 lb. falling weight equals $$\frac{5600}{52 \times 9 \times 60}$$ or two pounds per min. (approximately). The volume of two pounds of steam at atmospheric pressure is 53 cu. ft., which is to be compared with 12½ cu. ft. of free air, the average amount of air used per min. per 100 lb. falling weight during the day. The above figure of two pounds of steam per min. covers losses due to condensation and coal used in the banking of fires, etc.

At this plant, in normal times, coal costs \$6 per ton, which is a cost of \$24 per day for the operation of the hammers by steam as compared with \$15.38 per day by air. Of course at the present time the coal would cost \$10 a ton, which would make the difference a great deal more.

If the amount of air required above was furnished by a 1,000 ft. W. C. (Sullivan Tandem Compound Corliss) compressor running non-condensing, the amount of coal consumed would be $$\frac{170\ (\text{HP}) \times .75\ (\text{LF}) \times 23.5 \times 9}{7\ (\text{EVAP.}) \times 2000}$$ equals 1.93 tons. Adding 10 per cent for banking fires, etc., gives 2⅛ tons per day. If the compressor is run condensing the coal consumption would be about 1¾ tons per day.

Assuming the cost of coal at \$6 a ton as above and allowing \$5 for interest, depreciation and upkeep cost per day, the compressor, running non-condensing, shows a saving of \$6.25 per day, and running condensing, a saving of \$8.50 per day, over running the steam hammers direct by steam.

Changes Needed for Air Operation

Where steam hammers are to be operated by air, it is of vital importance to have the steam hammer piston valve ground to fit its cage. The valves and cages furnished by the steam hammer manufacturers are supposed to be equally good for steam or air but this of course is impossible, since with a large steam piston valve with no rings, a loose fit is necessary to allow for expansion.

It is also quite essential to have a much larger receiver than is usually furnished with the compressor, and a good idea is to have two, one at the compressor and the other as close as possible to the hammers.

Advantages of Using Air

1. The close fitting valve, which can be used on a steam hammer, when operated with air, accounts for a lot of the saving obtained. With loosely fitted steam valves a great portion of the steam leaks through into the exhaust without doing any work whatever.

2. There is no condensation in the pipe lines or in the hammer when operating with air. This condensation, when operating with steam is quite a serious matter and it is general practice to allow the hammers to float (that is, operate on short stroke) in order to keep the hammers warm and cut down the amount of condensation. It is also necessary to float the hammers for about a half hour before using in the morning, to get them heated up. In this method of course there is a great waste of steam, while with the use of air the hammer is ready to operate at any time; and when the job is finished, the hammer may be shut off completely by the valve in the pipe line, thus cutting out the leakage and loss of air when the hammer is not working.

3. When using steam, the piston rod packing has to be renewed once or twice a week, because there is danger that the packing will burn out and allow the condensed steam to fall on the work and on the operators. With air, one set of piston rod packing will last four or five months.

4. With steam there is always a certain amount of hot water dripping down on the men. With air this is done away with, and as the whole hammer remains cold, the machine is much more comfortable for a man to work with. This is especially desirable in changing dies after a job is done.

5. It is a simple matter to lubricate the air hammer and of course a great deal less oil is used than with steam, with which the water washes the lubricant away.

6. A more snappy, lively blow is obtained with air than with steam, therefore, better work is turned out, with an increase in production amounting to 10 or 15 per cent.

7. The exhaust from the hammers can be piped down, to blow the scale off the dies, thus obviating the use of a separate low pressure blower system.

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*Abstract of an article in the April issue of Forging and Heat Treating.

Manufacturing Standard Locomotive Repair Parts

A Method of Standardizing and Manufacturing Locomotive Repair Parts in Central Production Shops

BY M. H. WILLIAMS

WHEN manufacturing repair parts for locomotives in central production shops, it is desirable that they be machined to as near the finished state as possible since, owing to quantity production and the use of modern machines, finishing done in this department will cost less than when done in repair shops. In addition, the reduction of finish machine operations in back shops increases shop output and capacity. In order to determine the surfaces which may be finished and their respective sizes, the manufacturing department must carefully study local manufacturing conditions; also the condition of machines and tool equipment in the home and smaller shops where repair parts are to be used, an attempt being made to meet the average requirements of all these shops.

Relation Between Production and Repair Shops

In many respects the relations existing between the central production shop and repair shops is similar to that which exists between manufacturing concerns and their customers. In each case the manufacturer must cater to the requirements of the user and supply goods that will best meet the requirements and unless this be the practice, the shops where these parts are used will not receive the maximum benefits.

It is important to determine the number of articles that may profitably be made at one time in the central shop without overburdening the stock account. The nature of these articles, machines available or contemplated, requirements of repair shops and costs are also important factors. To give a few illustrations, articles that should be made on automatic machines can best be centralized in this shop. Work made on turret lathes should to a lesser extent be centralized depending largely on the number required at one time. Planer work on articles, several of which may be set up on the planer at one time, can as a rule be finished more cheaply in the central shop. Where the nature of the work is such that only one piece can be planed at a time there is not much to be gained by doing this in the large central shop as the work of setting up and machining will be practically the same wherever it is done. Ordinary lathe work can usually be done as cheaply in one shop as another. All that will be gained in the central shop will be the greater output that follows as a result of more modern tools, better supervision, facilities for handling and the use of gages and templets that would be justified for the central shop, but would hardly be warranted in each of the smaller shops.

Standardizing Semi-Finished Parts

In order to standardize the articles to be made, each should be carefully analyzed and a standard set to govern the following: step or grade sizes of bearing surfaces, diameters, tolerances, grades of finish and bearing surfaces that can be finished complete in the central shop. An example of this is the straight body or bearing surfaces of side rod knuckle pins and bushings. When setting these sizes a number of points must be taken into consideration such as the compression of the bushings when forced into the rod and the amount that should be allowed for running fits.

By step or grade sizes is meant the steps in sizes such as 1⅛ in., 1¼ in., 1⅜ in., etc., necessary to allow for wear of the part to which it is to be applied, or where the piece used for repairs must be larger or smaller than called for on the original drawings. Step sizes will apply largely to all motion pins. Surfaces that are to be rough machined at the time of manufacture, the sizes being made suitable to best meet the conditions when fitting to the place intended, include, for example, the taper ends of knuckle and valve motion pins, the outside diameters of bushings for the above, crank pin fits in wheel centers, etc.

In order that nuts shall accurately fit the threaded ends of crosshead pins, crank pins and similar articles, standards and limits should be set governing the maximum and minimum thread sizes. This is important as a number of screw threads used on locomotives are not regular U. S. screw threads. A number of different tapers are used in locomotive work and it is not suggested that these be changed. However, it is quite essential that each shop use gages and reamers of the correct taper; i. e., where the drawings call for a taper of ¾ in. per ft., this should be uniform in all shops. This subject is of interest to the central shop in order that parts produced there shall fit properly.

In order to give the readers the benefit of what has been done in various shops in the way of standardizing articles used for repair work, a few representative cases will be given showing the method followed when working up this data.

Side Rod Knuckle Pins

For parts of this nature some of the surfaces can be finished complete at the time of manufacture in the central shop. For example, these pins can be made to standard lengths, the threads cut, the holes for taper pins or cotter keys drilled and key-ways milled. This part of the machining operation would be the same for pins for a standard new rod or for those made larger than drawing sizes such as are used in rods that have been worn and reamed. This now leaves the two taper ends and the body to be considered. Concerning the two taper ends, it will be assumed that on the score of economy and high grade of repairs, the taper holes in rods when undergoing repairs are reamed barely enough to insure a true taper, and that the knuckle pins will each be individually machined to the correct size to fit these holes. This makes it desirable to manufacture the pins in step sizes which should be slightly larger than required so that they may be drawn from stock at the time of repairs and, with a small amount of tuning or grinding, fitted to the rod. The diameter of the two taper ends will be largely governed by the diameter of the body or bearing portion, the taper used and the length. Step sizes can readily be set for these in the following manner.

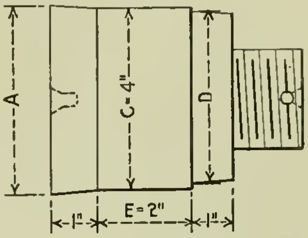


Fig. 1—Typical Proportions of Rod Knuckle Pin

For the purpose of illustration a knuckle pin of the conventional shape and size is shown in Fig. 1 with the diameter of body *C* equal to 4 in., the length of body *E* being 2 in. and each taper end being 1 in. long. The total taper is 1 in. per foot which is regular from end to end. It is evident that the 4 in. body size can be maintained as long as the small end of the larger taper is equal to or greater than 4 in. and the smaller taper at *D* does not exceed 4 in. Therefore a pin with a 4 in. body can be made to fit any rod coming within this range by machining the two taper ends. Where the rod has been reamed above 4 in. at the taper *D*, it becomes necessary to make use of a pin with a body larger than 4 in. and in this case step sizes should be adopted. In order to reduce the number of step sizes to a minimum, it is advisable to make the advances between the steps as large as the design of pin will admit.

The maximum difference that can be allowed in step sizes as above mentioned will be governed by the taper and length of the body *E*, the formula for which is as follows: taper per inch equals taper per foot divided by 12; maximum step size equals taper per inch multiplied by length of body *E*. With the pin in question the total taper is 1 in. per ft., or 0.0833 in., which equals, when multiplied by 2 (the body length), 0.166 in. This is the largest amount the step sizes can advance from one size to another with a pin of the size and taper shown in Fig. 1 at the same time insuring a full surface on the body *E* and the two taper ends. The above method may be followed for any degree of taper or length of body.

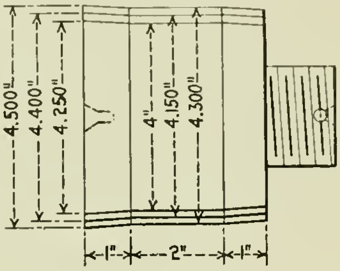


Fig. 2—Proposed Step Sizes for Knuckle Pins

By a similar calculation the maximum size at the large end of taper *A* is found. With the pin in question the distance from the large end of the pin to the smaller taper at *D* is 3 in. Multiplying 0.0833 by 3 equals .250 in. Therefore the greatest possible diameter for this pin at *A* will be 4.250 in., or 4¼ in. Likewise for a pin which is 4¼ in. at the large end *A*, the smallest taper at *D* will be the same as the body, or 4 in. The least diameter of the small taper at *D* will be 0.166 in. less than the body size, or 4 in. minus 0.166 in.=3.834 in. Therefore a pin that has been blanked out 4¼ in. at *A* and 4 in. at *D* can be refitted where the taper at *D* is not larger than 4 in. or smaller than 3.834 in. To make the larger taper at *A* greater than 4¼ in. with a 4-in. body will only result in additional machining at the time of fitting to the rod. It is therefore evident that to meet all conditions the 4 in. body pin should be blanked out in the central production shop with the large taper at *A* equal to 4¼ in. and the smaller taper at *D* equal to 4 in.

The next question to be considered is the largest step sizes necessary when fitting a pin to a rod that has been reamed larger than 4 in. at the taper *D*. It is evident that the pin (Fig. 1) cannot be used as the smaller of the two tapers would not true up. Calculations have shown that for the pin in question the step sizes may theoretically be advanced by 0.166 in. but for simplicity, it is advisable to make use of step sizes agreeing with common fractions or easily remembered decimals. In this case the step sizes may be ⅛ in. or 5/32 in. or, in decimals 0.150 in., this being a question generally settled after going over the requirements for both the pins and reaming sizes for bore of bushings. For the pin in question a step size of 0.150 in. would fit in very well. It is not the purpose at this time to go into the relative merits of common and decimal fractions. However, for such work as fitting knuckle pins and general central production products decimals have decided advantages and where setting step sizes their use is to be recommended.

A taper of 1 in. per ft. has been considered thus far but if a greater taper is called for, such as 1½ in. per ft., the step sizes may be advanced by ¼ in. On the other hand a lower taper will reduce the step sizes. In either case the larger pin will start in where the smaller one leaves off. In some cases, especially where grinding is practiced when fitting the pins to the rods, it is advisable to use two or more step sizes for the taper ends for each body step size. As an illustration in the case of the pins explained having step sizes of 0.150 in., the body step sizes would advance by 0.150 in. and the taper ends by 0.075 in. Fig. 2 illustrates in outline a knuckle pin similar to that shown in Fig. 1 with two larger sizes superimposed on the original. This will serve to show more fully the plan of setting step sizes.

Detail step sizes for knuckle pins such as would be required for repair work are shown in Fig. 3, together with directions for all extra operations, limits, method of manufacture and general information. These lists are generally shown in blue-print form and often show pins for several classes of locomotives on a single print. They have the advantage that at the time of manufacture the central shop will have complete instructions as to the sizes, surfaces to be finished or left rough, etc. Likewise the repair shops will know what is being manufactured. Fig. 3 calls for the pins to be casehardened on all surfaces except the thread, and as a result of following this practice it would be necessary to grind the surfaces when fitting rods. Unfortunately many railroad shops are not equipped with adequate grinding machines and to meet this condition the pins are often supplied ground on the body and carburized, which permits turning the taper ends on a lathe and afterwards hardening. The body being to correct size does not require machining at the time of fitting to the rod, so that this operation is eliminated.

Where the bodies of pins are ground to exact sizes all pins of the same nominal size will have interchangeable bodies and as a result it is not necessary to finish the bodies when used for repairs. Fig. 3 also calls for the body to be ground 0.015 in. larger than the finish size previous to casehardening, this being a practice not generally followed in railway shops but quite common in manufacturing concerns. It is done for the following reasons: the pin or similar article as it comes from the automatic machine or turret lathe will often run out of true on its centers and if casehardened in this condition the grinding will remove a greater amount of the casehardening from one side of the pin. This possibility is avoided by first grinding. Again this rough grinding becomes the finishing operation for the blanking out operation and as a result it is not necessary to hold the blanking operation to such close limits which results in greater output. The

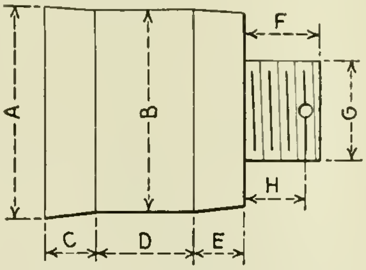


Fig. 3—Knuckle Pin Dimensions in Detail

Class	A	B	C	D	E	F	G	H	
M ..	4.250 in.	4 in.	1 in.	2 in.	1 in.	1½ in.	2 in.	1 in.	Standard
M ..	4.400 in.	4.150 in.	1 in.	2 in.	1 in.	1½ in.	2 in.	1 in.	1st Step
M ..	4.559 in.	4.300 in.	1 in.	2 in.	1 in.	1½ in.	2 in.	1 in.	2nd Step
M ..	4.700 in.	4.450 in.	1 in.	2 in.	1 in.	1½ in.	2 in.	1 in.	3rd Step

Note—Blank out body B between 0.20 in. and 0.30 in. large. Center and grind 0.010 in. large. Caseharden all over except threads. Grind body B to sizes given, using limits of plus or minus 0.001 in. Place in stock.

saving in time when blanking out and the decreased number of spoiled pieces will generally be found sufficient to offset the cost of grinding. Actually the rough grinding on a suitable machine only takes from two to three minutes.

Knuckle Pin Bushings

It is evident that the bore of knuckle pin bushings should, where possible, be finished a definite amount larger than the knuckle pin body at the time of manufacture in order to allow for the necessary running fit between the two. When determining the bore size the fact must be remembered that the bore will be reduced to a certain extent when pressed into the rod owing to compression. In addition, there is the factor of the rod holes for the bushings not being a true circle or regular from end to end which will result in the bore of bushings after application taking to a certain extent the same shape as the rod bore. This irregularity will be governed by the thickness of bushing walls and is a question of the bushing giving way to the rod or vice versa. The amount the bore will compress is generally determined by making actual measurements of bushings before and after pressing in the rod and noting the differences.

The question of tools and appliances in repair shops for the purpose of truing the rod bores will have quite an influence on the proposed bore sizes. That is, if the repair shops are well equipped with grinding machines, adjustable reamers or suitable boring machines for correcting irregularities in the rods, the amount the bushing bore is larger than the pin body can be set with sufficient accuracy so that it may be made right at the time of manufacture, thus meeting the average requirements of pin and bushing fitting and avoiding individual fitting at the time of making locomotive repairs. Where this condition does not exist it is generally necessary to fit each pin to its companion bushing.

On some roads it has been recommended that there be from 0.005 to 0.008 in. lost motion between pin and bushing when the bushing is home in the rod, in order to allow for the flow of oil and the weaving of the rods when in service. To this amount must be added about 0.004 in. to compensate for the closure of the bushings resulting from forcing into place. This indicates that the bore diameter should be from 0.012 in. to 0.015 in. larger than the diameter of the pin body. (The foregoing applies to repair shops that make a practice of truing the rod bores when irregular.)

Bushings which form a bearing for the knuckle pins should be as true as possible. Good practice has shown that the bore should be ground after blanking out in the case of soft steel bushings, or ground after casehardening for the hard bushings. Where this grinding is done in the central shop a large number of bushings may be ground in a batch on internal grinding machines at a small cost. The number of step sizes of bushing bore will be governed by the knuckle pin body diameter, that is, they must be some 0.012 in. to 0.015 in. larger than the pin body sizes as shown in Fig. 3. A table of bushing sizes is shown in Fig. 4.

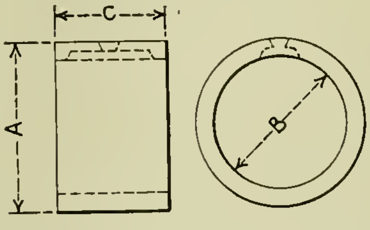


Fig. 4—Step Sizes for Knuckle Pin Bushings

Class	A	B	C	
M.	4¾ in.	4.015 in.	2 in.	Standard
M	4⅞ in.	4.165 in.	2 in.	1st Step
M	5 in.	4.315 in.	2 in.	2nd Step
M	5⅛ in.	4.465 in.	2 in.	3rd Step

Note—Blank out and bore 0.008 in. small. Drill oil hole and mill oil way. Caseharden bore, leaving outside soft. Grind bore to sizes given, using limits of plus or minus 0.001 in. Place in stock.

The outside diameters are generally turned when applying in the rod, therefore setting of step sizes will be governed largely by the average enlargement of the rod holes into which they are to be fitted. Generally if these advance by 3/16 in. or ¼ in. all conditions will be met. These sizes are also shown in Fig. 4.

Selective Casehardening

By a process of selective casehardening the bore of a bushing may be made hard and the outside and ends soft, thus making it possible to turn the outside of hardened bushings. This is done in the following manner: After completion of the machine work, the oil holes are filled with fire clay and the bushings filled with casehardening compound, retained in the bushing by caps *A* and *B* and bolt *C*, Fig. 5. These bushings are then placed in regular casehardening boxes, the space between the box and the bushings being filled with burned foundry sand and the box heated in the usual manner. When removing from the furnace, the end caps are removed, the compound emptied out and the bushings quenched. This results in the bore being hard. However, as the ends and outside were not carburized these surfaces remain soft and may be turned as readily as soft steel or iron. This process has the advantages of hard center and soft outside that admits of the central shop grinding the bore and any shop applying.

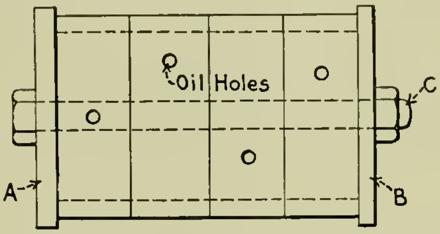


Fig. 5—Arrangement for Case Hardening Bushing Interior

As in the case of knuckle pins, it is advisable to prepare tracings showing the dimensions for blanking out, finishing and other operations such as drilling oil holes, milling oil ways, etc.

Valve Motion Pins and Bushings

It is doubtful whether any part of locomotive repairs should receive more careful attention than fitting the valve motion pins and bushings to the levers and to each other. If there is too much lost motion between pins and bushings the valve will not function properly. On the other hand if they are fitted too closely there is the possibility of heating and binding that often causes engine failures. These pins are comparative small articles that lend themselves to quantity production on automatic screw machines in the central shop where, with suitable machinery, the bushing bores and body sizes of pins can be ground to gage sizes and will properly fit each other. As a result, at time of repairing the locomotive and the work of applying will be reduced owing to these surfaces having been previously finished.

Interchangeability, or the standardization of running fits is important. In some shops it is the practice to fit each pin body to its companion bushing bore and not maintain a standard size for the two and as a result of this lack of uniformity, the levers so joined must be kept in pairs and applied to the same locomotive. This requires individual fitting of these two parts in addition to fitting each to the levers. Where the bodies of pins and the bores of bushings are each ground to standard gages these surfaces become interchangeable and as a result, companion levers need not be kept in pairs; also the pins or bushings may be fitted to the levers independently of each other. This independent fitting is in many respects an assistance to the repair shop as follows: first, the cost of machining at the time of repairs is reduced on account of eliminating the fitting of the pin body and bushing to each other; second, when several locomotives of the same class are undergoing repairs all similar levers may be repaired in lots, which is more economical than changing from one lever to another for each pin or bushing; third, it is not necessary to keep levers in pairs or place them back on the same locomotive. This interchangeability can be applied to practically all levers with the possible exception of that holding the link block, which is liable to be of varying size and require individual fitting.

Step Sizes for Valve Motion Pins

In many respects valve motion pins and bushings are smaller editions of knuckle pins and bushings and the same general rules will apply. When setting step sizes for bushing bores and pin bodies, it is advisable to consider the number of reamers and gages that will be required and combine the sizes where possible in order to reduce these to a reasonable number. The pins will have bodies of varying lengths and to attempt to make the step sizes as great as the tapers will admit of is liable to lead to complications. Therefore, it has been found good practice to adopt sizes varying by 1/16 in. for the pin body and bushing bore. That is, assuming that the drawings call for bodies 2 in. in diameter, the first oversize is 2 1/16 in., the next 2⅛ in. and so on providing the valve rods are sufficiently large to admit of the extra size without reducing their strength below the danger point.

The smaller of the two taper ends should, as in the case of the knuckle pin, be made in sizes to equal the body and the larger end such size as may be necessary in order to continue the taper from the small to the large end.

The holes for the cotter keys and the key to prevent the pin from turning may be drilled, the end threaded and afterwards casehardened, or where used in a soft state, the body may be ground to standard gage or micrometer size. The taper ends are in some cases ground to step sizes at the time of manufacture so that they may be fitted by simply reaming the lever to the required size. In other cases these surfaces are only rough machined at the time of manufacture and when fitting, the taper ends are ground to fit the levers. Both of these practices have certain advantages. Where the tapers are ground they may be fitted in any shop by simply reaming the levers. To offset this, it becomes necessary to maintain a greater variety of pins of differing step sizes, also maintaining a uniform taper of reamers in all shops. This is at times a difficult problem and another objection is that of enlarging the holes owing to the more frequent reaming which will hasten the time that the levers must be scrapped.

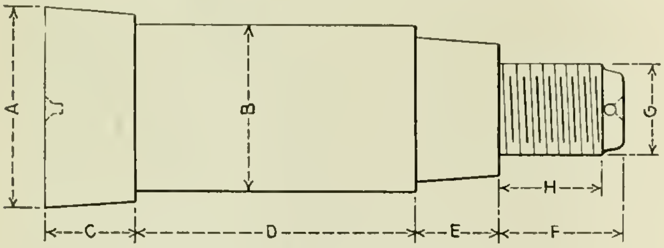


Fig. 6—Step Sizes for Eccentric Rod Pins

Class	A	B	C	D	E	F	G	H	
M	2.250 in.	2 in.	1 in.	3½ in.	1 in.	1¼ in.	1⅛ in.	1¼ in.	Standard
M	2.312 in.	2 1/16 in.	1 in.	3½ in.	1 in.	1¼ in.	1⅛ in.	1¼ in.	1st Step
M	2.387 in.	2⅛ in.	1 in.	3½ in.	1 in.	1¼ in.	1⅛ in.	1¼ in.	2nd Step

Note—Blank out body B 0.020 in. large. Center and grind 0.010 in. large. Caseharden all over except threads. Grind body B to sizes given, using limits of plus or minus 0.001 in. **Place in stock.**

Simply reaming the levers enough to true the surfaces of the holes and fitting the pins to the same will insure a longer life of the levers and reduce the number of step sizes kept in stock. However, where the pins are casehardened it is necessary to grind the taper ends, making grinding machines necessary in shops where these are applied, or resort to selective casehardening. The latter plan of finishing each pin to fit the hole has in practice been found to be the more desirable. The step sizes of eccentric rod pins are plainly shown in Fig. 6.

The nominal diameter of the bore of valve motion lever bushings will be governed by the sizes of pins they are to pair with. The amount that should be allowed for a running fit between the pin and bushing has never been well established for locomotive work. However, in some shops it is the practice to allow from 0.003 in. to 0.005 in. play between these two parts and this practice appears to be satisfactory, it having been found that less than this minimum amount is liable to cause heating or galling, and more than the maximum amount too much lost motion. In addition to the amount that should be allowed for the running fit, an allowance will have to be made for the compression of the bore when forcing the bushing into the lever. As a result of these two, practice has shown that the bore of bushings when completed in the central shop should, as a general rule be from 0.006 in. to 0.008 in. larger than the pin body diameter. When setting step sizes governing manufacture it will be found advisable to keep within these limits.

At the time of fitting to the levers, eccentric rod bushings are turned or ground on the outside to fit the holes. Therefore it is not necessary to maintain close sizes when blanking out. Generally making this diameter in steps of 1/16 in. or ⅛ in. larger than the drawing sizes will be found satisfactory for the average run of levers. In many cases the outside diameter is increased in step sizes similar to the bore. The bushings are made principally from bar stock or seamless tubing. When made from either materal it is advisable to ream the bore at the time of manufacture about 0.010 in. small and finish grind to such diameters as may be determined upon. Where the bushings are hardened the grinding is done after the hardening and should be to close limits and measured and checked with plug gages. While manufacturing, the oil holes may be drilled, oil ways milled and other work that may be necessary performed.

These bushings, like the side rod knuckle pin bushings, may be selectively casehardened as shown in Fig. 5. Where this practice is followed they may be turned and are therefore readily applied in any shop.

Cross-Head and Crank Pins

Cross-head pins are larger editions of side rod knuckle joint pins such as have been previously explained. Therefore the same general methods may be followed when determining upon sizes and planning for their manufacture. These pins except in the larger sizes may readily be blanked out on turret lathes, the keyways milled, ends threaded, holes drilled and such other work performed as may be called for. By determining upon standard diameters for the body such as 4 in., 5 in., etc., this surface may be ground in the central shop to gage or micrometer sizes so that at the time of application to the crosshead the only machine work necessary will be turning the taper ends. This is a point worthy of careful consideration. By making the body to a standard size the front end brasses may, at time of repairs, be bored to a standard plug gage which is a definite amount larger than the pin. This practice will make it possible to use standard boring cutters for all rods to which new pins are applied, and result in the eventual standardizing of this part of the repair work.

In order to provide for badly worn cross-heads or to make use of worn brasses, it is at times necessary to use step-sized pins, but there are so many variables owing to different designs of cross-heads that it would be difficult to set a hard and fast rule to govern all cases. However by carefully going over the designs and requirements, sizes may be set to cover their manufacture and finish or semi-finish, as may seem desirable.

The larger sizes of crank pins are often beyond the capacity of turret lathes and must from necessity be blanked out on center lathes. However, there are a number of the smaller sizes that come well within the range of the larger turret lathes such as the Steinle, Gisholt, Libby and similar classes. On account of the number of these required it will be found advisable to make a careful study of the possibilities of centralizing their manufacture. One practice followed when manufacturing is to make the pins to correct length, thread, drill center holes in hollow pins, drill holes for cotter or taper pins, finish collars to standard sizes, rough turn the bearing surface about 1/32 in. large and rough turn the portion fitting the wheel center some ¼ in. to ⅜ in. large. After the completion of this blanking out the bearing surfaces are ground to gage sizes. By this process the work of fitting to the wheel center is materially reduced. Fig. 7 shows a form covering crank pins.

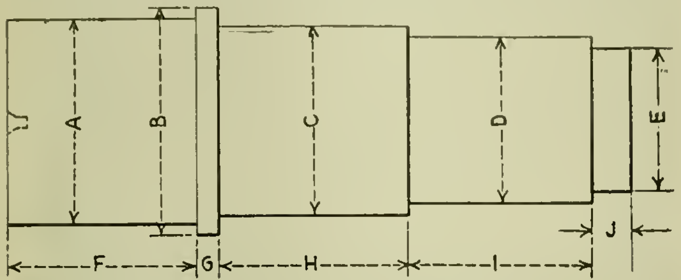


Fig. 7—Step Sizes for Small Crank Pins

Class	A	B	C	D	E	F	G	H	I	J	
M	6½ in.	7 in.	6 in.	5 in.	4 in.	8 in.	½ in.	6 in.	5 in.	2 in.	Front Standard
M	6¾ in.	7 in.	6 in.	5 in.	4 in.	8 in.	½ in.	6 in.	5 in.	2 in.	Front 1st Step

(*To be concluded in the August number.*)

Pneumatic Grease Gun

BY NORMAN McCLEOD

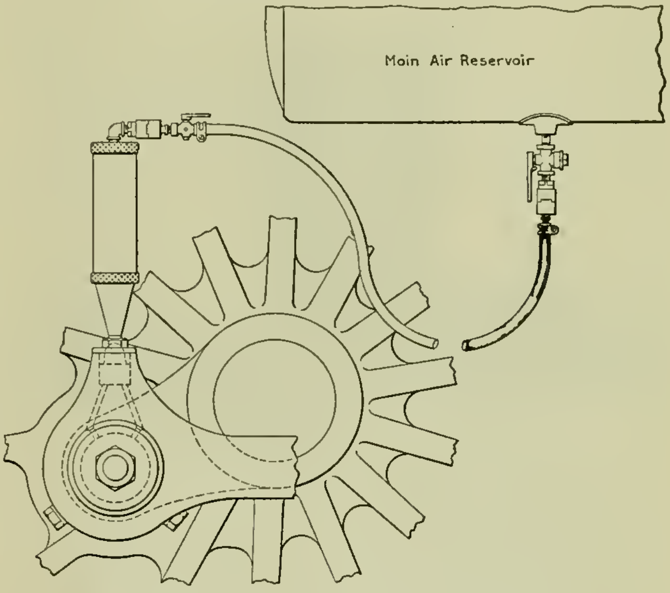
At large locomotive terminals a great deal of time is consumed and engines are often delayed while refilling the grease cups of main and side rods. Cinders and foreign gritty substances get into the cups and finally to the bearings, caused by the present practice of placing caps (which are always full of grease) on the side rods. These pick up foreign substances and introduce them into the cups when the caps are replaced. It also frequently happens that the cups are not easily accessible which necessitates moving the engine Even then the caps may be difficult to remove, owing to the disadvantage of using a wrench in close quarters. All of the above troubles are eliminated and over one-half of the time and labor is saved by the use of a pneumatic grease gun, such as has been designed and has proved a success on a prominent eastern railroad.

The device consists of a 3-in. brass tube cylinder with a conical shaped end and cap, fitted with a piston and rings, the general arrangement being shown in the illustration. The idea is to have all grease cup caps tapped and fitted with a standard ¾-in. pipe plug, so that the operator with a small wrench (often with his fingers alone) can remove the plug and insert the conical end of the gun. The end of the gun is made to fit loosely into the ¾-in. plug opening, the gun being charged with a 9-in. piece of 3-in. diameter grease which has been previously rolled in graphite. Connection is made to the air reservoir at small engine terminals, or to the permanent air connections at each side of the inspection or ash pits at other terminals, with a ¼-in. hose of sufficient length to reach all cups on the longest locomotive.

The air being turned on at the reservoir, or permanent connection as the case may be, the operator unscrews all ¾-in. plugs and with the gun held vertically proceeds to fill the cups by opening the small ¼-in. standard cock until such time as he feels the gun begin to rise up and out of the cup. He then knows that the cup and passages to the pin are filled solidly with grease. Continuing the operation, all cups are filled in a remarkably short time. The length of the gun permits the operator to reach cups behind the guides or in inaccessible places. It has been found that by the use of the hose coupling shown the work is greatly facilitated. Both the top and bottom heads or ends of the gun are shown to be knurled so that recharging the gun is expedited as they are screwed home by hand.

To refill the gun, the conical end is removed and a 9-in. piece of grease is pushed in, forcing the piston back to its proper place, an air vent taking care of the compression that might otherwise occur. It has been found that rolling the grease in graphite not only reduces the friction in the cylinder, but introduces just enough graphite to make it an ideal lubricant. When it is considered that in a busy time at some of the larger terminals, from 80 to 100 locomotives are handled every ten hours and that twelve men on three tricks, or four men on a trick of eight hours, are required to look after nothing but filling grease cups, this operation is not a matter of small importance.

Another disadvantage of the prevailing method of filling the cups is that frequently much time is lost by the operator in not being able to replace grease cup caps owing to his having tried to put too many cakes of grease into the cup. Mutilation of the thread also is common. By the use of the gun, these and many other similar impediments are eliminated.



Pneumatic Grease Gun for Filling Rod Cups

When the connection is made to the main reservoir, it is advisable to blow out the reservoir at certain intervals as more or less dirt and sediment collect and ought not to be forced into the grease to later find its way to the bearing. One of the criticisms of the device in its present form is its weight (when filled the gun weighs 14 lb.) and no doubt if made of aluminum it would be considerably lighter. The weight as given, however, seems to be necessary to make the device function properly as it insures the cups being absolutely filled before the gun begins to rise, which is the signal for the operator to shut off the air.

Electric Arc Welding in Railroad Shops

Explanation of the Characteristics of Arc Deposited Metal and Some Samples of Welding

BY A. M. CANDY

General Engineer, Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa.

Although much has been written concerning the application of arc welding to railroad equipment, many roads have not applied the process as extensively as possible. There is room for improvement in the quality of electric welds and the best methods of producing consistently good welds are of vital importance to managements, supervisors and welders. With this fact in mind a brief review of the characteristics of good arc deposited metal will be given, showing how metal can be improved by proper procedure and control of the process. A few important applications of arc welding are also illustrated.

Determining the Characteristics of Deposited Metal

To determine the characteristics of arc deposited metal put down under various conditions and in various ways, a number of large masses of metal were built up on steel plates. In one case each layer was brushed off thoroughly with a wire brush and in the other case each layer was cleaned off thoroughly by sand blasting. Standard 5-in. test specimens were turned out of the solid deposited metal and tested, the results being as follows:

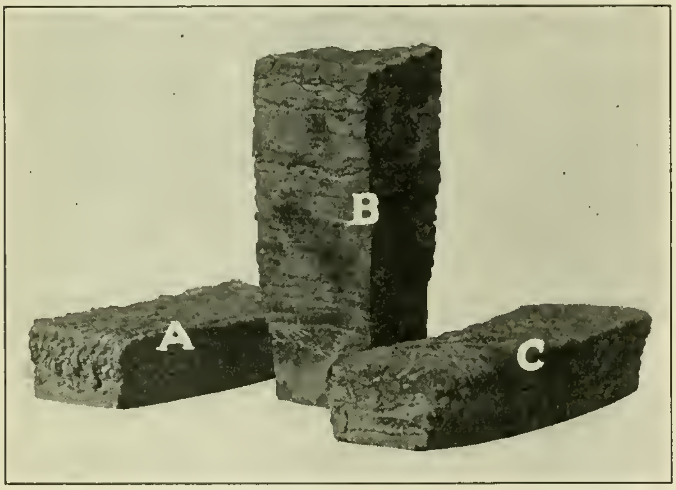


Fig. 1—Deposited Metal Built Up on Steel Plates to Determine Effect of Direction of Metal Deposition on Strength of Weld

Wire Brushed Samples

	Pounds per sq. inch			Per cent	
Test	Ultimate tensile strength	Yield point	Elastic limit	Elongation	Reduction of area
No. 1	58,825	41,000	40,000	8.2	19.9
No. 2	54,650	35,000	29,000	6.5	13.4

Sand Blasted Samples

	Pounds per sq. inch			Per cent	
Test	Ultimate tensile strength	Yield point	Elastic limit	Elongation	Reduction of area
No. 5	56,075	35,875	29,000	16	23.4
No. 6	58,225	......	......	18	27.8

The fractures of all these specimens had the appearance of high grade partially annealed low carbon cast steel. It is interesting to compare tests No. 5 and 6 with No. 1 and 2 and observe that while sand-blasting the layers of metal did not appreciably effect the tensile strength, it did practically double the elasticity of the metal as indicated by the increase in per cent elongation and reduction of area.

To determine the effect of the direction of metal deposition on the strength of a weld, three blocks of deposited metal were built up on steel plates as indicated at *A*, *B* and *C*, Fig. 1. Standard 5-in. tensile test pieces were turned out of these solid blocks of deposited metal. Those from Specimen *A* stressed the metal in the direction of the strings of deposited metal. Those from Specimen *C* stressed the metal at right angles with the direction of the strings of deposited metal. Those from Specimen *B* stressed the metal at right angles to the layers of deposited metal. The results of the tests on these specimens were as follows:

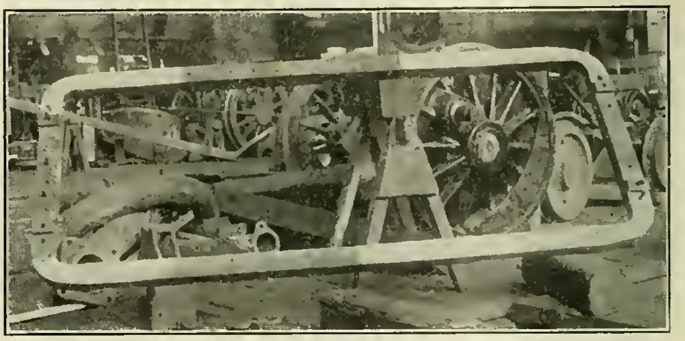


Fig. 2—Locomotive Mud Ring Reclaimed by Arc Welding

Tensile Tests

	Pounds per sq. inch			Per cent	
Specimen	Ultimate tensile strength	Yield point	Elastic limit	Elongation in 2 in.	Reduction of area
No. 1	56,000	33,400	27,500	18.1	30.8
No. 1	56,075	35,875	29,000	17.0	23.4
No. 1	58,225	......	......	18.0	27.8
No. 3	51,375	29.050	24,000	14.1	18.8
No. 2	40,875	29,400	24,250	4.4	15.9
No. 2	43,500	28,900	20,000	4.9	7.0

Compression Tests

Specimen	Load at 10 per cent compression pounds per sq. inch	Elastic limit pounds per sq. inch
No. 1	63,250	32,000
No. 3	60.750	30,700
No. 2	60,700	30.400

Shearing Tests

Specimen	Stress at shear pounds per sq. inch
No. 1	39,200
No. 3	41,450
No. 2	38,500

To determine the effect of forging on arc deposited metal, a sample similar to *C*, Fig. 1, was prepared so that standard 5-in. test pieces could be cut from it and leave a sufficient amount of stock for forging before cutting additional test pieces. The results of tensile tests on the unforged and forged portions of this specimen are as follows:

	Pounds per square inch			Per cent	
Specimen portion	Ultimate tensile strength	Yield point	Elastic limit	Elongation in 2 in.	Reduction of area
Unforged ...	42,187	29,125	22,125	4.6	11.4
Forged	56,900	31,600	28,000	27.6	59.5

It is interesting to observe that the proper forging not only increased the strength of the metal from that of a medium good weld to that of a very good weld but also improved the ductility to a marked degree, the per cent elongation being increased 500 per cent and the per cent reduction in area being increased 423 per cent.

Examples of Arc Welding on Locomotives

The mud ring of a locomotive boiler which has been badly corroded on the water side in service and which has been reclaimed by building up the corroded areas to their original shape and thickness is shown in Fig. 2.

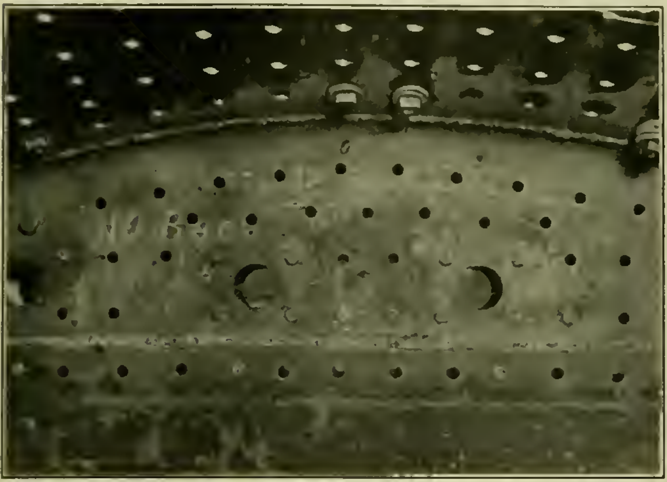


Fig. 3—Example of Direct Overhead Welding at Junction of Crown Sheet and Fire Door Sheet in Locomotive Firebox

The appearance of a set of neatly and effectively welded flues is familiar to all and this application of electric welding has proved a big money-saver for roads where bad water must be used. For this work to be successful, however, the operator must be skillful and know how to get good fusion. Welding flues is a rather exacting operation because the operator is forced to make a partial overhead weld under the lower edge of the tube. Before attempting to weld flues, the operator should make certain that none of the copper gaskets show beyond the edge of the bead. Most operators prefer to start at the bottom center and weld up around one side to the top center of the flue; then start at the bottom center and weld up around the other side to the top center.

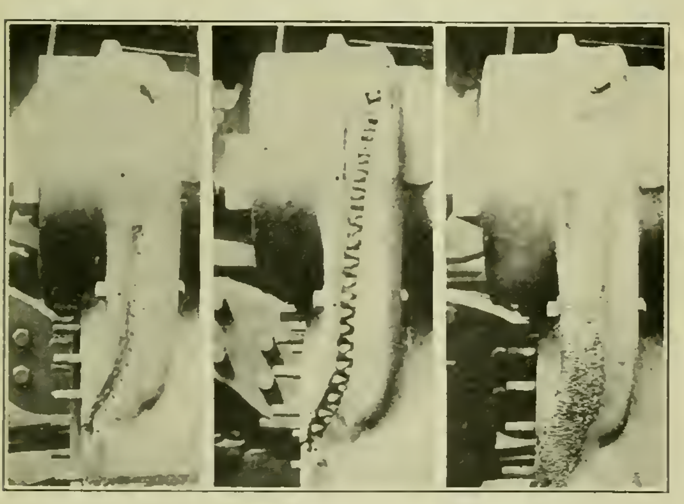


Fig. 4—Locomotive Cylinder Wall Beveled, Studded and Welded

A close view of a direct overhead weld at the junction of the crown sheet and fire door sheet in a locomotive fire box is shown in Fig. 3. Direct overhead welding is very difficult and requires an experienced operator with a steady hand and a welding generator which delivers a stable, tenacious arc.

A typical example of cylinder welding is given in Fig. 4 which shows the cylinder wall V-ed out, studded and welded. The greatest advantage (aside from lower cost) claimed for electric over oxy-acetylene welding is that no preheating is necessary. Electric welding is valuable for many building operations such as the eye of a cross head which is badly worn. In this case the welding process is much more satisfactory and cheaper than bushing the hole. Piston heads can be made up of thin cast steel centers and cast iron rims beveled off so that metal fused into the groove to hold the two together, making a steamtight joint. Four holes are usually drilled in the steel centers near the groove and plug welded to give additional strength. Fig. 5 represents a locomotive deck plate the corrugated impressions on which have been worn smooth and then built up as indicated.

Fig. 5—Corrugations on Deck Plate Built Up by Arc Welding

The shafts of worn journals are sometimes built up by welding, but this is an emergency repair because the deposited metal will not have the same physical properties as the shaft steel. This is evidenced by Fig. 6 which is a section through a typical shaft. This section was polished and etched to show the deposited metal as the white layers on the outside. Immediately below are the block scalloped shapes which are the portions of the shaft affected by the heat of the arc and deposited metal. These portions have been raised above the critical temperature and then rapidly cooled (quenched) by the rapid flow of heat into the main body of the shaft and also through the deposited metal to the air. The dark grey central portion represents that part of the shaft which has been unaffected. Subsequent heat treatment will reduce the hardened shaft area to its original condition but no amount of heat treatment will affect the deposited metal appreciably. Some very interesting and instructive data along this line

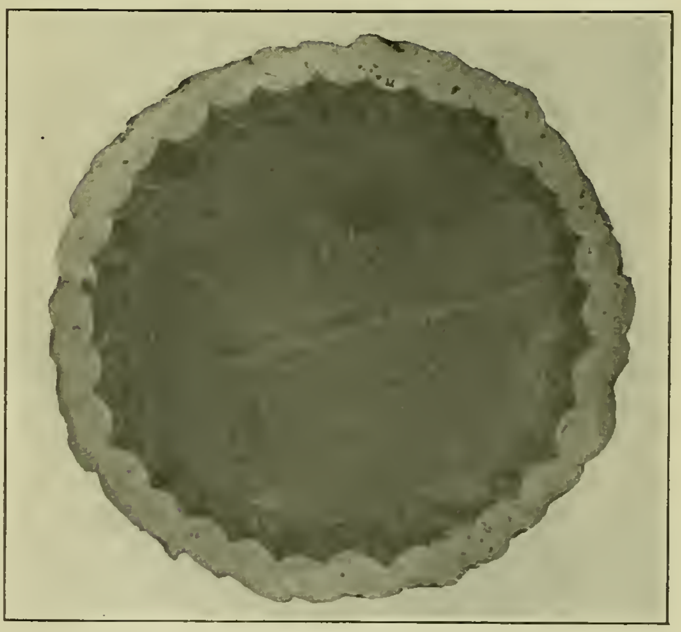


Fig. 6—Section Through Built-Up Shaft Showing Effect of Arc Welding

was recently published by T. D. Sedwick, engineer of tests, C. R. I. & P., on page 114 of the February, 1921, issue of the *Railway Mechanical Engineer.*

A car shop kink is illustrated in Fig. 7 which shows a section of car siding with finishing nails welded head on to the plate. Felt lining is pushed over the nails which are then clinched. In doing this work the positive side of the welding circuit is connected to the car body and a pair of pliers is connected to the negative side of the welding circuit. The operator grasps a finishing nail in the pliers and touches the head to the plate withdrawing it to form an arc which produces a small puddle of metal in the plate and liquifies the end of the nail. The operator then pushes the nail head into the molten puddle and releases the pliers, leaving the nail welded in position.

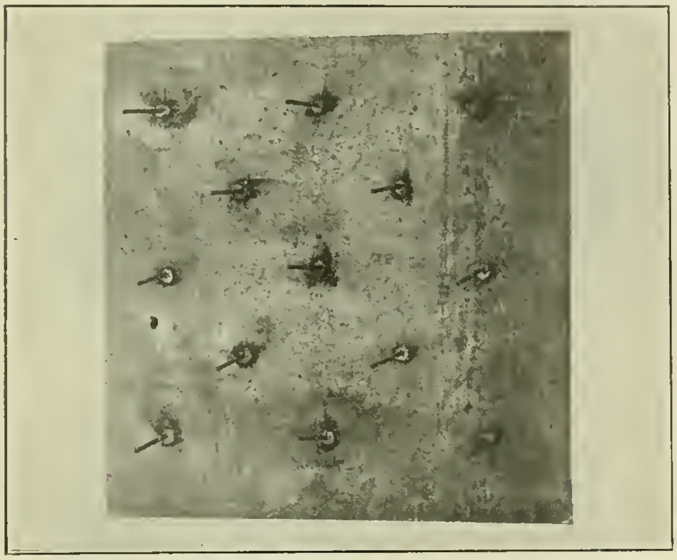


Fig. 7—Nails Welded to Car Side to Hold Felt Lining

Frame welding is another operation in railroad shops affording great possibilities of economy. A valuable feature of the electric arc for this work is the localization of heat, no allowance being necessary for contraction in cooling. In frame welding, quality is of the utmost importance and every care should be taken to improve as much as possible the characteristics of the arc deposited metal.

The Use of Gas in Railroad Shops

BY ROY G. MONROE

Denver Gas & Electric Light Company, Denver, Colo.

To anyone who has watched the setting or removing of large locomotive driver tires, where solid or liquid fuels were used, it is readily apparent that this is one heating operation wherein can be demonstrated most of the inherent advantages of gaseous fuel. It was formerly necessary to heat these tires over wood or forge fires while lying on their sides. This necessitated handling the tires while hot, also a greater expansion to allow for the time lost during the laborious placing of the tires upon the drivers. Later on, burners were devised for using gasoline and other liquid fuels which made possible the heating of the tires while in place on the driving wheels, but which were still far from satisfactory.

It was difficult to adapt liquid fuel burners to the circular shape of the tires; heat control and distribution were uncertain, and the fire and accident hazards were extremely great. Frequently men would be sprayed with burning gasoline or kerosene and several bad accidents occurred in this way. Also it was not uncommon for sufficient burning liquid to run onto the floor to set fire to the flooring some distance from the operation. The caution necessary in handling liquid fuel slowed down production of all the men working in the vicinity, necessitated the assigning of greater floor space to this operation and caused more or less grumbling and dissatisfaction among the men.

Gaseous fuel does away with all of these objections and is also cheaper. The fire and accident hazards are almost wholly eliminated, no accidents or fires being recorded in Denver. The removing and setting of tires by gas is performed on an unprotected wooden floor, a minimum of floor space being used with no additional space required by the heating operation.

Records show consumptions of from 200 to 600 cu. ft. in the expanding of 60 in. by 2½ in. tires, the time varying from 5 min. to 14 min. Tire expanding is done in both the roundhouse and machine shop. Where gasolene or kerosene is used, somewhat in excess of 1½ gals. is required per tire. Improved liquid fuel burners are available which, with careful operation, give but little trouble. Nevertheless gas possesses many advantages in regard to fire hazard, convenience, safety of handling, and storage.

The advantages of gas in the babbitt shop over solid or liquid fuels can be demonstrated very conclusively. Solid fuels require too much time on the fires; liquid fuels burn out the pots, and both fail on account of poor heat control.

A most popular use for gas in this shop is in the pipe heating furnaces, of which there are two, each 30 in. long. The burners are divided into two equal parts, so that if desired gas can be turned on at each end, heating a section of pipe 24 in. long, or gas can be turned on at but one end, heating a section but 12 in. long. A 1½ in. pipe can be heated to a cherry red in but little over 60 sec. These furnaces will heat pipe from the smallest sizes up to 4 in. diameter. A 4 in. pipe packed with sand to keep it from buckling can be heated ready for the bending rolls in less than 10 min. These furnaces heat the pipe with a minimum of scale and danger of burning and are greatly appreciated.

Paint Shop and Car Shop

In these shops the advantages of gas over any other fuel are very important, the principal uses for gas being paint removal with torches, for tinner's furnaces and water jacketed glue pots. Gas for the burning of paint from coaches is much cheaper than any competing fuel and also saves much labor cost. A consumption test demonstrated that 1,200 cu. ft. of gas was sufficient to remove all the paint from a first-class vestibuled coach, including body, sash, screens, doors, etc. A disastrous fire might easily spread to adjoining shops and where coaches and material worth many thousands of dollars are stored. The fire hazard is so great in these shops that gas would be welcomed at several times the cost of any other fuel.

In the tool room, high-speed steel and other heat treatment furnaces for tempering, annealing, case-hardening, pack-hardening, etc., will displace other fuels. It is advisable to use pyrometers and the perfect heat control obtainable with gas, together with the non-oxidizing interior which can easily be obtained in gas-fired furnaces, enables even inexperienced workmen to accomplish good results.

CUTTING WITH HYDROGEN GAS.—In an article on the Industrial Application of Hydrogen, H. L. Barnitz points out some of the advantages of the oxy-hydrogen flame for cutting metals. Where hydro-carbon gases are used for this purpose, the carbon unites with the molten metal and causes excessive slag formation. Owing to this tendency gases containing carbon retard the action of the flame, give rough cuts and prevent the action of the flame on the metal from penetrating to any great depth. Hydrogen, on the other hand, gives a speedy, deep and clean cut with oxygen which is not obtainable from all other gases used in conjunction with oxygen as a preheating flame. Iron and steel over 24 in. thick may be cut with the oxy-hydrogen flame.

The Foreman; His Qualifications and Training

Steps Should Be Taken to Find and Fit Men for the Responsibility of Foremanship

BY L. E. GARDNER

DISCUSSION was invited in a recent issue as to the duties of foremen, their prime responsibility, the manner in which they are and should be selected, the training they should receive before and after assignment to such positions, and the placing of the responsibility where it belongs when foremen fail to make good.

These are exceedingly important subjects. Men are more in demand than materials, more difficult to handle and control than machines. The present with its complex industrial conditions, to say nothing of the problems of the future, demands leaders beyond the possibility of past methods to supply. There has been a dearth of leadership. We have been prone to wait for men to come to the front. Some of them have come, but not in sufficient numbers nor with sufficient ability and training to meet the needs. We must go out and find them, and then train and fit them for the work they must do.

Responsibility

The foreman occupies a strategic position. He is responsible for the immediate output of the shop, for securing and maintaining maximum effort and efficiency from each man in his department, and for so co-ordinating and correlating the work of these individual men as to secure the best results from the department as a whole. Without a competent experienced captain or manager to secure teamwork, it is impossible to utilize to the fullest the ability and experience of the individual members of the team.

The foreman is also in a large measure responsible for the loyalty of his men. He embodies to them the corporation, he is the company's man. He interprets company policies. He is the executive with whom the rank and file come closest into contact. As his subordinates respect or disrespect him, so will be their attitude toward the corporation as a whole.

The foreman is also responsible for the care of equipment, for its maintenance and repair, for the installation of labor-saving devices, for the speed of machines and the methods of doing work, for reclamation of scrap and avoidance of waste, for shop operations and processes; safety and sanitary measures also come within the scope of his duties.

The greatest of his responsibilities, however, is for his men, their selection, training, promotion, workmanship, conduct, aspirations, and ideals. In general, he has the right to hire and to fire. To be able to hire intelligently, he must have the ability to judge men, to pick out good material from poor or mediocre, and to recruit his forces with men physically, mentally and temperamentally fitted for the work for which they are being employed. On the other hand, he must know how to exercise the right to fire so as to rid the company of undesirable material, set a proper example for others in maintaining and enforcing discipline, but be able to do it all in a spirit of fairness and justice which will redound to the good of the company as a whole. In addition to selecting and training men for the immediate work, the foreman must also know how to select and train men for promotion, for except where a definite training system is in vogue, the responsibility for making promotions and for the training given workmen and subordinate officials, rests largely with the foreman. Even under a well-organized and supervised training system the foreman is always an important adjunct, if not an actual part, of such organization. It must be borne in mind, too, that it is from their number that higher foremen and other executives are ultimately recruited. Unless the right men are started up the ladder, much time and energy will be wasted and many valuable men overlooked. After all, the foreman is responsible not only for immediate output, but also for ultimate output as well. Without competent supervision and organization only mediocre results can be achieved.

Requisites

Since the duties of a foreman are so important, and his success or failure so far-reaching, let us consider some of the requisites. We will then be in a better position to make proper selection and to decide on the kind and amount of training he should receive.

Among the many requisites in a good foreman, the first is his knowledge of and skill in the work of the men he is to supervise. Without this he is not in a position to give necessary orders or instructions, to properly organize his department, assign the work to be done, intelligently judge the quality or the quantity of work performed by the individual members of his force, or to command the proper respect of his subordinates. Especially is this true in subordinate executive positions, wherein the foreman comes in closest contact with the workmen, where it is necessary for him to set a personal example and often take hold of the work and show the workman how it should be done. A foreman in such a position can undoubtedly secure better results if, having been through the mill himself, he knows of what the daily grind consists, and because of such knowledge and personal experience can hold better the confidence of his men and lead and inspire them to greater effort.

So important is this qualification in a foreman that in the past it often has been considered the only essential qualification and men have been selected solely because of their ability as mechanics, with no thought as to whether they possess the other traits necessary for success. Ability to perform the work of the men being supervised is, however, only one of the many desirable qualifications. Even this is not so essential in higher as in subordinate positions. Railway men are prone to think of engines, shops, and cars, and to neglect the question of men and organization. The chief clerk with natural executive talent, strengthened by experience and association with competent and seasoned executives, combined with his knowledge of the department organization and policies and his knowledge of the men to be supervised may be more promising material than the mechanic who knows nothing but machines.

Qualifications

There are many qualifications to be considered. Perhaps the most essential of all, is the knowledge of men, the ability to understand them, to handle them, to lead and to guide them. Does the man about to be promoted know when and how to give orders, when to give directions, when to merely make suggestions? Does he make a study of human nature? Does he properly sympathize with his men, and is he able to appreciate their viewpoint? Is he honest with both workmen and employers? Does he know when to censure and when to praise, and how much and in what manner this censure or praise should be administered? Is he tactful and diplomatic? Is he fair to all, and yet firm in his decisions and rulings? Is he self-reliant and resourceful, energetic and industrious, intelligent and quick to learn, ambitious, conservative and yet progressive? Does he possess initiative? Has he enthusiasm? Is his personal character above reproach? Is he popular with associates, both with subordinates and with superiors? Is he a good mixer, yet able to maintain proper dignity? Can be control his tongue and his temper? Is he blessed with good health and physique and vigor? Does he have vitality, steam, go, push? Is he courteous? Is he a dynamic, driving, I-want-it-done-now sort of a man? Has he capacity for leadership, either dormant or developed? Is his personality such that he possesses that consciousness of personal power, that mental poise, that something alive, something dynamic, something electric, something that without effort wins the other fellow mentally and temperamentally, often in both respects? In brief, is he able to create in his men interest in their work, an ambition to excel, a joy and pride in their work? Above all, does he possess, and is he able to instill in his men, intense, unquestioned loyalty to the company? Unless he is himself loyal to the core, willing to sacrifice his own personal gain for the good of the employer he serves, he is unworthy of being considered for advancement.

Men Available in Every Shop

All of the qualifications mentioned or suggested are desirable in a foreman. But no one individual will be found who possesses all the requisites for wise leadership. However, some men possess more of them than others. Some men are blessed by birth and by environment with capacity for leadership. Some have acquired it by training and experience. Still others may possess the dormant talent, which if given proper nourishment and cultivation, will develop beyond expectations. Our duty is to locate the talent, then to develop it. Surely these qualifications are so important, that promotions should not be left to chance or to the favor of an ignorant short-sighted subordinate. Without question the problem is big enough to demand that systematic, well-planned consideration should be given to the picking out of these men and to developing the talents they already possess and to supplying the deficiencies they lack.

In passing let us say that it is not necessary to go outside the company's organization to find men suitable for advancement. There is plenty of good material in any large well-organized corporation for practically any vacancy that may occur, especially if there is a training department or at least some sympathetic executive near by to lend a helping hand in times of troubles. Not all who are tried out can be expected to make good. Neither should a man be condemned for one failure. One successful venture or one dismal failure does not make an ultimate success or an endless failure. Too often when a young foreman falls, some one is ready to knock him down again and gloat over his failure. Of course a successful foreman must be tempered by surmounting his many failures. The testing given him should strengthen him, but a helping hand at the right time may turn a dismal failure into a well-earned success.

Training Needed

Some managements seem to think that foremen are born, not made. It is true some men are born with natural instincts for leadership but these natural instincts must receive training and experience in order to develop. Turn a so-called natural born mechanic loose in a shop to root-hog-or-die and he will learn some things, it is true, but he will fall far short of a similarly endowed young man who has been given a systematic, well-planned course of training. So with leaders. Some will naturally forge to the front in spite of obstacles, but is it not equally true that the average man at least will prove much more capable and efficient if given a chance to profit by a course of training?

Some of the preliminary training may be given before the young man starts up the ladder, but just as the apprentice boy must be given his training while actually engaged on mechanical work, so the training for foremanship must be given while the man is actually working in a supervisory capacity, either in direct charge or acting as an assistant. The executive must be advanced by easy stages from the simple to the complex problems of management. It must be some one's duty to see that the man being trained for foremanship is given experience on the various phases of supervisory work. Men should be tested—not once but repeatedly. It is a waste of time to permit each man to work out each problem for himself. There are so many problems fundamentally alike that each one should be given an opportunity to profit by the mistakes and experience of others.

If there is one thing more important than another that a foreman should learn, it is the importance of having some one trained and ready to take his place. A man's executive capacity is measured by the lieutenants he has to carry out his policies. It is a short-sighted official who is afraid to select too big a man for his assistant. Every man should consider it a part of his work to prepare his successor. Subordinates should be selected with this end in view.

It has been the aim to show the necessity for foremanship training rather than to suggest methods of training, believing that once the importance of the subject is recognized, means will be found for carrying out the project. Among the successful methods being followed by wide-awake managements are the following:

Regular lectures are given foremen, once a week, the lectures and meetings being thrown open for general discussion. In order that this may be well-organized and rapid, sometimes two or three foremen are notified in advance to prepare short discussions. At some meetings stenographic reports are taken. At others certain foremen are asked to give a synopsis of the discussions. In most cases the speaker is an employee of the company, but at times some of the very best men available from outside companies give the addresses. Both classes of speakers are recommended. The company lecture is less expensive, and the speaker being well-known and his ability recognized the employee usually feels a more real and human interest in what he has to say. On the other hand, the outside speaker is often more widely informed, has perhaps specialized on certain topics, and in general is a better and more interesting speaker. At some meetings certain foremen are asked to discuss problems assigned to them in advance. Sometimes problems are assigned and each asked to write out a solution, two or three of the best being read at the meeting. In all cases discussions are as untrammeled as it is possible to make them, each man being encouraged to speak his mind freely and without fear of suffering thereby.

Regular visiting programs have been arranged whereby a foreman in one class of work may visit men engaged in similar work elsewhere. In such cases a report of the visit is made. Sometimes two men are sent together and given suggestions in advance as to what inspections to make or ideas to look for. Men holding similar jobs in different shops are called together for conventions and discussion of matters of common interest. In such cases it is well to give the men opportunity of mingling with each other between formal sessions, for frequently greater benefit is derived from these personal conversations than from the convention proper.

Courses of study have been arranged, these relating definitely to the work over which the foremen have supervision, and being supplemented by sufficient outside work to broaden the man's general training. Too many of our shop foremen are woefully ignorant as to what is going on in the outside world, or even outside of their own department. Some of the subjects discussed are: the products and aims of the company, the policies being followed, biographical sketches of the men responsible for the growth and development of the company, including those now in charge. The official personnel in general, also the geography of the road. How production may be increased. How co-operation of men may be secured. Safety matters and accident prevention. Sanitation and health. Materials and equipment. Shop processes and operations. Care and repair of machinery. Labor-saving devices. Inspection. Rush jobs. Reclamation of scrap. Expense items. Cost accounting. How data may be secured. Importance of furnishing correct data. What records should be kept. Delays in getting material, causes and results of such delays. Testing materials. Speed of machines. Promotion from the ranks. Governmental control and regulation. Working conditions and their effect on management. The National Agreement. Labor conditions in general. How to secure loyalty and co-operation of men. Discipline. Labor turnover, its cost and prevention. Incentives for good workmanship. What motives actuate men, how may these be supplied? What punishment should be meted out for violation of rules? Piece work and bonuses. Present and future output. Shop betterments. Personnel improvement.

Would not a study of such questions as these serve to broaden and increase the usefulness of the foreman, be he old or young, experienced or inexperienced? Let us repeat, the young subordinate official should not be left to work out all these problems for himself, but rather should be given opportunity under proper supervision for finding solutions for many of these problems before he meets them in actual supervision, and to try out some of the lessons learned. He should not confine his study to books or magazines, nor to advice or suggestions from others, no matter how good they may be, but should study men themselves, not only the men he is to supervise, but men whom he knows have made good. Let him pick out some successful leader with whom he is personally acquainted, and ascertain the secret of his success, what methods he pursues, how he utilizes his time, what his attitude is towards both subordinates and superiors, why he has succeeded while others have failed. Let him be assigned occasionally as assistant to some successful executive willing to give him the benefit of his experience. The prospective foreman can also be tried out to good advantage during the temporary absence of a regular foreman.

The full importance of training foremen is only just being realized. The movement is in its infancy, but is fast gaining ground. Managements are realizing as never before that it is not only possible but absolutely necessary to train men for executive positions.

In a recent investigation of records and plans for the training of foremen, questions were sent to 50 different companies. Twenty-five of these reported having regular plans for training foremen. Many of the others reported that plans were under consideration, with a view of adopting some system of training. Evidently they had felt the need for it. One-third of these companies reported regular meetings of foremen. Where the foremen could not leave their work, the meetings were held outside of working hours. Some of these companies reported regular inspection trips, with reports being made of such trips. Eight reported calling their men together for set lectures, some of these being given by company officials, others by outsiders, both producing good results. Thirteen reported giving regular courses of training to their foremen. Ten reported co-operation with outside educational institutions. Some reported paying the cost of tuition in correspondence courses provided the foremen did regular work on such courses.

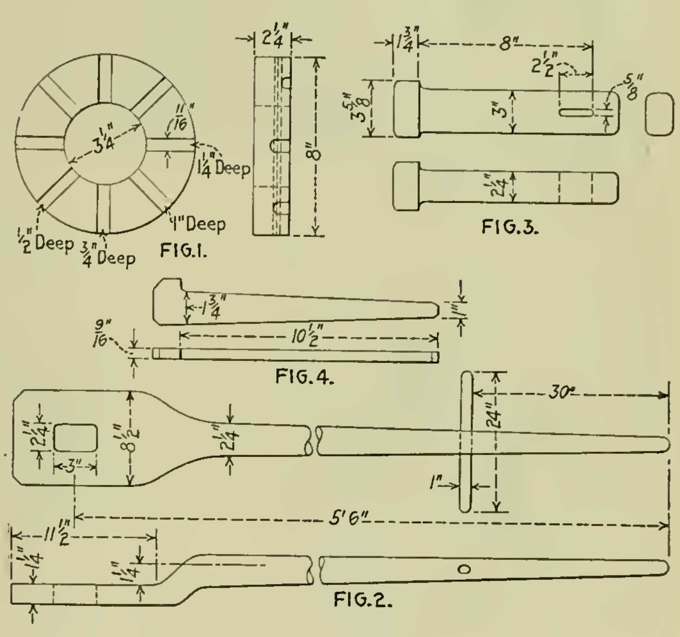
These replies were from manufacturing corporations rather than from railway companies, but the methods pursued are worthy of serious consideration by railway managements. No foreman has a more difficult task than the railway shop or roundhouse foreman. No other corporations are in greater need of competent supervisory forces than are the railway companies today and the need will be even greater in the years to come. Competent foremen cannot be trained over night. The period of training should extend over many years, the more the better. Now is the time to begin. Railway managements may well give the subject serious consideration. Successful foremen are not born, they are made. Those born with talents of leadership must be given an opportunity to grow and develop. Some of them should be transferred to other shops. At least their talents should be cultivated so as to bring out the best that is in them. The results accomplished will more than justify any effort that may be made to meet this situation. The question of leadership is one of the biggest problems the railways have to solve. May it receive the attention and consideration it deserves.

Holder for Side Rods and Drawbars

BY M. C. WHELAN

Foreman Blacksmith, St. Louis-San Francisco, Kansas City, Mo.

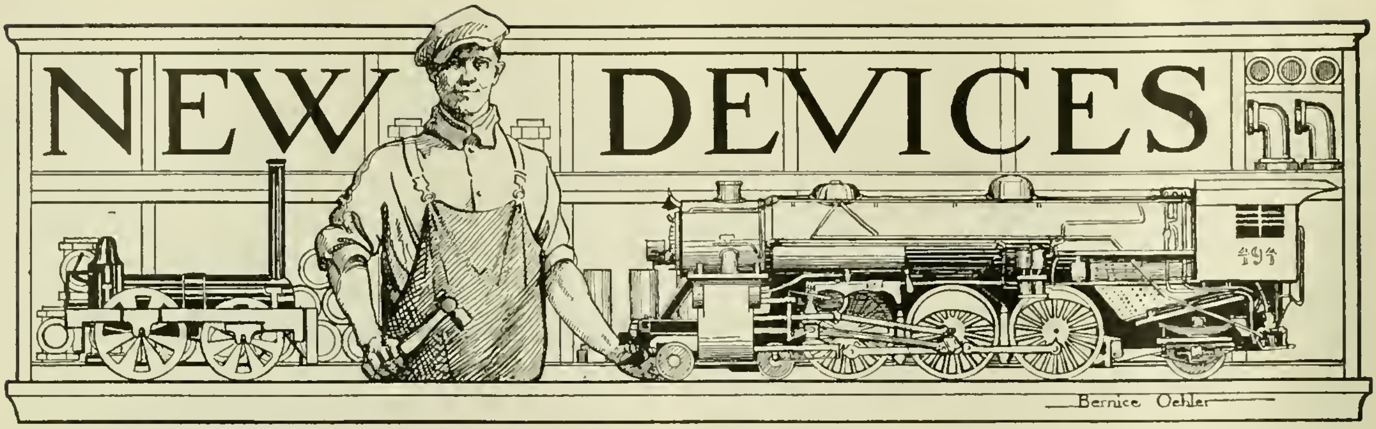
For holding drawbars, side rods and other parts while forging, the arrangement illustrated has proved both convenient and readily adjustable to different sizes of work. The difficulty of using tongs is eliminated and heavy parts can be handled at the hammer with maximum ease. The device is safe to operate and cheaply made, the parts being plainly shown in the illustration. They consist of a forged, offset handle (Fig. 2) with one end flattened and provided with a 2¼ in. by 3 in. hole. Fig. 1 shows the heavy washer which is held in place by the pin (Fig. 3) and taper key (Fig. 4). To give a greater purchase in revolving the drawbar or rod, an auxiliary 24 in. crossbar made of 1 in. round stock is applied through the handle, as shown in Fig. 2.



Device for Holding Drawbars While Being Forged

When this device is used for holding side rods in the forging operation, a bushing is placed in the solid end of the rod and the washer, pin and taper key applied as usual. A ram may then be used to upset the rod without injuring the brass bushing in any way. This device can be used in forging many other parts of locomotives and cars, enabling them to be held firmly and accurately.

The Safety Department of the Missouri Pacific, which is conducting a campaign to reduce accidents among its employees, awarded first place in its "Safety First League" to the shops at De Soto, Mo., for the month of May. During this period the 382 employees at the De Soto shops worked without an injury of any kind.



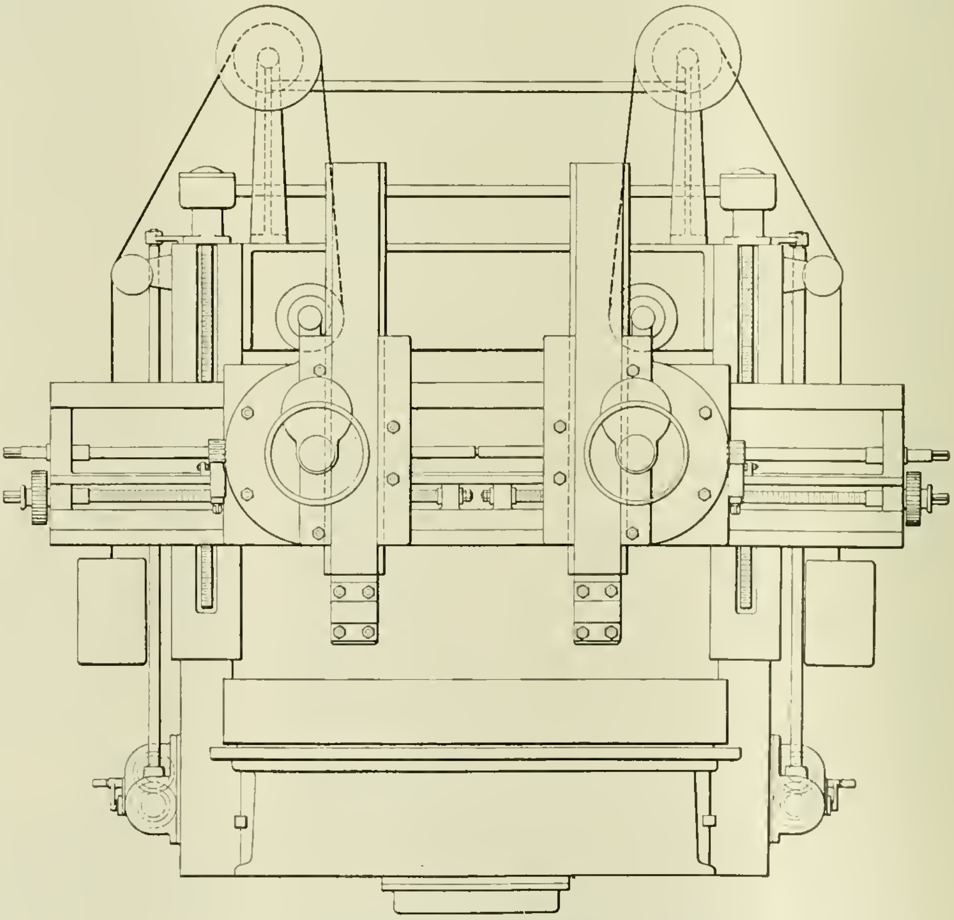
High Power Vertical Turning and Boring Mill

FOR turning and boring operations on locomotive wheel centers and tires, the Colburn Machine Tool Company, Cleveland, Ohio, and the Dale Machinery Company, New York, have recently co-operated in developing the high power, 90-in., boring mill illustrated. The first six machines of this type were built on order for the American Locomotive Company, this firm's standard specifications for heavy duty wheel boring and turning mills of the movable cross-rail type, being adopted as a general guide for the designers.

The design of the mill follows established practice in the construction of machines of the movable cross-rail type but with several new features as follows. Power is delivered to a single pulley from a 42½-h.p., 3-1 variable speed motor which runs on a 220-volt direct current circuit. The driving pulley, shown at *A* in the cross sectional view is 44 in. in diameter by 12 in. face width, and carries a 10-in. belt. This pulley runs free on its shaft, connection to the gearing being accomplished by means of an Edgemont clutch *B* of the disc type, which will transit over 100 h. p. The chief advantage of this arrangement is that the clutch is disengaged, and the brake *C* applied with the same lever, making it unnecessary to overcome the momentum of the high-speed motor armature, driving pulley and belt. This allows the operator to stop the table instantly or move it around slightly when setting tools or work.

From the driving pulley, power is transmitted through gears which are enclosed in the bed of the machine and run in oil. Provision for efficient lubrication is one of the important features of this boring and turning mill. Feed lubricators are used to deliver a constant supply of oil to the spindle drive gears and feed change gear, thus assuring their efficient operation and largely eliminating the personal equation. All gears are made of steel with cut teeth, so that they possess ample strength and durability. The full back gear ratio is 104 to 1 with a maximum gear speed of only 1,064 ft. per min. The table is driven by a pinion *D* meshing with an internal gear which affords an advantageous condition of tooth contact.

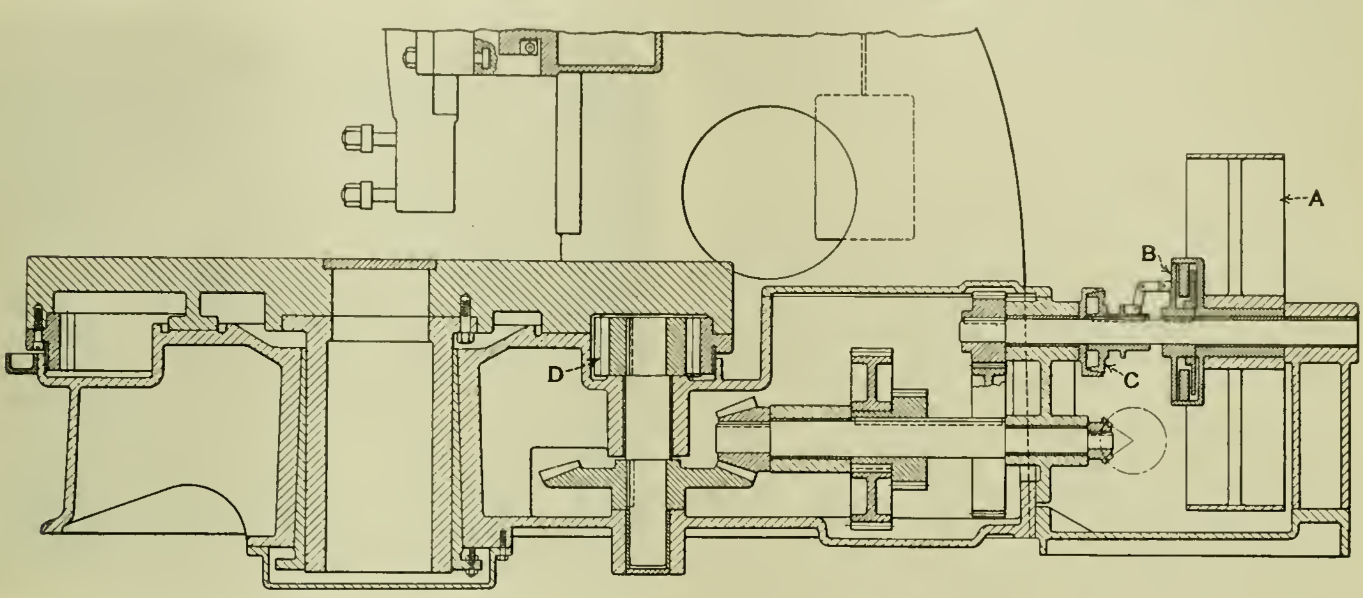
The machine is designed to take a maximum feed of ½ by ⅛ in. in steel, with a cutting speed of 60 ft. per min. In working out the design, the fact has been constantly borne in mind that this machine is intended for severe service, and the construction worked out accordingly. The bed is of box form, reinforced with ribs and flanges, a cast-steel trough surrounding the bed to catch cutting compound as it drips from the table. Large fitted bolts connect the bed and housings, which are also of box form, reinforced with ribs and flanges. The spindle is mounted on the table and has a suitable tapered bushing in the bed, provided with means of adjustment to compensate for wear. A powerful built-in



From View of Colburn 90-In. Vertical Turning and Boring Mill independent four-jaw chuck is provided on the table. In common with other gears in the drive, the table gear and pinion run in oil. All gears and other running members of the mechanism are effectively guarded.

A 5-hp. independent motor provides power for elevating and lowering the cross-rail, which is equipped with two independent saddles, made right and left hand to adapt them for working close together. Either saddle may be moved to the center of the table for use in boring operations. All wear between the cross-rail and saddles, except on the face of the cross-rail, may be taken up with cast-iron gibs. The cross-rail is of the narrow guide type, being made of cast-iron. The saddles are made of steel. The rams are provided with cut rack teeth, and both swivels have adjustment up to 30 deg. on each side of the vertical position. Swivelling is accomplished by means of a worm and ratchet adjustment. Rapid hand movement is provided for the rams and they are equipped with counterbalances, arranged to exert a direct pull on the rams in any angular position. The machine is flexible and special attachments such as power cross feed can be readily applied if desired. The idea, however, has been to eliminate expensive attachments not essential to the special purpose for which this machine was designed. All feed gears are made of steel with cut teeth and the feeds are reversible. Changes of feed are accomplished by sliding gears and clutches.

The dimensions of this machine include: Maximum swing, 91½ in.; maximum distance between table and cross-rail, 46 in.; spindle travel, 42 in.; diameter of table, 87 in.; diameter of track, 52 in.; width of track, 6 in.; diameter of spindle, 18 in.; length of spindle in bearing, 28 in.; table speed with back gears in, 1½ to 4½ r.p.m.; table speed with back gears out, 6 to 18 r.p.m., number of available table speeds, 32; minimum vertical feed, 0.037 in. per table revolution; maximum vertical feed, 1⅛ in.; minimum horizontal feed, 0.022 in.; maximum horizontal feed, 0.672 in.; number of available vertical and horizontal reversible feeds, 8; approximate weight, including the motor, 67,000 lb.



Cross Section Showing Table Support and Driving Mechanism

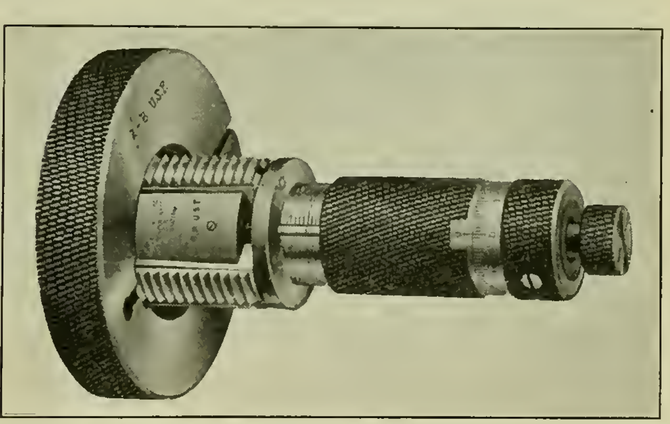
Expanding Internal Thread Micrometer

A UNIQUE tool for measuring internal threads easily and accurately has been developed by John Bath & Co., Inc., Worcester, Mass. This tool, as shown in the illustration, is distinctly a thread micrometer, giving the size of a tapped hole, ring thread gage, or other internal thread directly in units of ten-thousandths of an inch.

The four measuring jaws are supported and held in alinement by close fitting dovetail slots in the body of the micrometer, which is movable by a micrometer screw. The moving parts are lapped and fitted without play and the micrometer is said to be as rigid as a solid plug. This rigidity enables different persons to secure the same measurement on a given piece.

Adjustment is provided so that when wear occurs on the measuring jaws the micrometer may be referred to the master reference ring, set correctly to size, and the wear taken up on the graduated collar.

Where holes are tapped or threaded in quantities, this internal thread micrometer should be especially valuable. By its use the action of taps with different lubricants and cutting compounds, the amount a tap cuts oversize, the effect of every thousand pieces as regards tap wear, and many other conditions may be known, accounted for and corrected. In addition, the need of numerous trial plugs, checks and thread gages will be eliminated. The micrometers can be furnished with any number of threads per inch and in different sizes ranging from 1 in. to 5 in. in diameter as may be desired.



Bath Internal Thread Micrometer and Master Reference Ring

Sixty-Inch Lathe of Exceptional Power

THE 60-in. triple-geared engine lathe, illustrated, is a powerful machine recently completed by the Houston, Stanwood & Gamble Company, Cincinnati, Ohio. It is made with a 42-ft. bed in one section but can be provided with any length of bed ranging from 12 ft. to 42 ft. in 2-ft. steps. The large steady rest, shown, has a capacity of 23 in. to 37 in., being equipped with bronze shoes. The smaller steady rest has a capacity of 2 in. to 23 in. and is also equipped with bronze shoes on the jaws. The lathe may be furnished in a variety of drives, including cone, variable speed motor, constant speed motor, or single pulley drive. The illustration shows a 35-hp. variable speed motor operating on 220 volts direct current.

The rugged construction of the head-stock and arrangement for geared motor drive is plainly shown in Fig. 1. The different positions of the handwheel and levers are indicated by letters which allow the operator to check up the speeds in connection with a speed plate mounted on the head-stock. The reverse plate, quadrant and all levers are made of steel castings. The head-stock gears are made of .50 carbon steel in the majority of cases, having stub teeth cut with a pressure angle of 20 deg. The internal ring gear is made of a ring forging without weld. Forced lubrication of the head-stock is accomplished by means of a pump mounted at the rear of the lathe and belted to the motor shaft, oil gages and indicators showing the operator at all times whether the oil is circulating properly.

A good idea of the arrangement and rugged proportions of the carriage also is given in Fig. 1. The front and back portions of the apron are tongued and grooved through the center in male and female sections, being doweled and substantially bolted together. This construction provides practically a solid apron with no chance of the bearings shifting or getting out of alinement. All gears are of steel, cut with a coarse pitch and wide face. A patented positive angular tooth clutch drives the feed mechanism and allows the operator to engage and disengage the feed instantly under heavy cuts, without excessive strain on the operator's wrist or hand. The rack pinion and rack of heat treated steel are designed to more than meet the demands of the heaviest feeds taken.

The full swing tool post shown in Fig. 1 is mounted on the left of the carriage. A small rapid traverse motor and controller, mounted on the left of the apron provides power traverse by throwing in the lever directly in back of the hand wheel which engages a friction clutch. By moving this lever towards the operator, a positive clutch is engaged, allowing the carriage to be traversed by hand. The controller is so constructed that the operator must hold the handle in position when operating this motor since it will spring back to neutral position as soon as released.


Fig. 2—View Showing Chips Taken in .50 Carbon Forging

The apron motor controller bracket and dial are shown mounted on the right of the apron. This bracket controls the starting, stopping and reversing of the main motor, the action being transmitted through the horizontal shaft (shown near the bottom of the lathe) to the controller by a chain and sprocket. A long ratchet lever at the left of the apron is used when it is desired to exert great power on hand adjust-

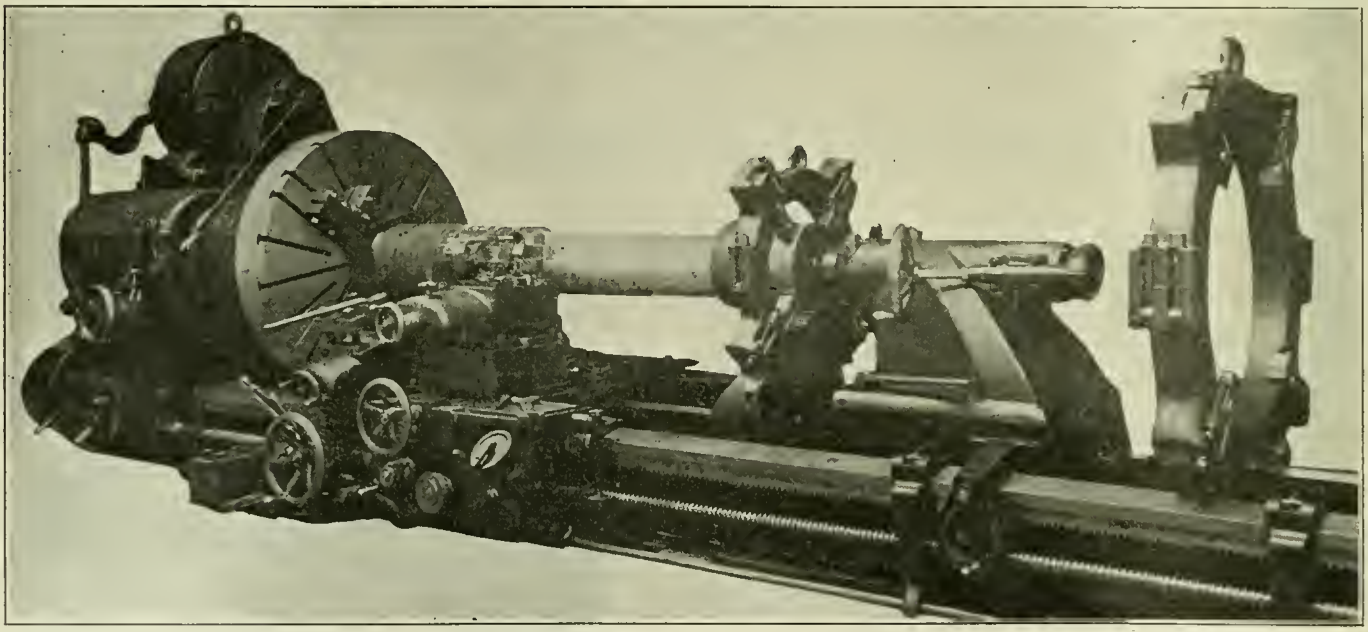


Fig. 1—Houston, Stanwood and Gamble 60-In. Engine Lathe Designed for Heavy Duty

ment of the carriage or when feeding the carriage along the bed under heavy cuts.

A patented support for the lead screw and controller rod is illustrated. It has a bronze bearing for the screw feed rod and may be fastened to the vertical hanger by means of a large cap bolt, being accurately located by two dowels. This support can be easily and quickly removed from the bed and replaced at any position along the bed length.

Some idea of the power of this lathe may be obtained by reference to Fig. 2, which shows the big chips taken in a .50 carbon, hammered forging with a manganese content of 0.68 per cent. The illustration shows a 3¾ in. reduction in diameter of the forging. The cut was 1⅞ in. deep, the feed being ¼ in. and the cutting speed 15 ft. per min. The ammeter during this time registered from 230 to 275 amperes, which at 220 volts indicated a power input to the machine of 75 to 80 hp. After running this cut for 10 or 15 revolutions of the forging, the lathe was stopped. To try the maximum power of the lathe it was immediately started again with the cutting tool underneath the full depth of cut. Under this enormous load the motor started, with the result that a 2 in. by 3 in. high speed steel tool was broken off. When this occurred the ammeter showed from 400 to 500 amperes and the fuse blew out. The test demonstrated the ability of the lathe to withstand the heaviest cutting feeds and speeds utilized in modern practice.

Rail Washer Reduces Flange and Rail Wear

WORN flanges on locomotives and worn, slippery rails are sources of much annoyance and expense to railroads, the trouble being accentuated especially where grades and curves predominate. Numerous devices have been tried in an effort to lubricate satisfactorily the contact between flanges and rails, and these flange lubricators are quite satisfactory, providing the grease or oil does not feed so fast that it covers the tread of the wheel, or the ball of the rail, and causes slipping. Besides oil flange lubricators, there are also rail-washing devices.

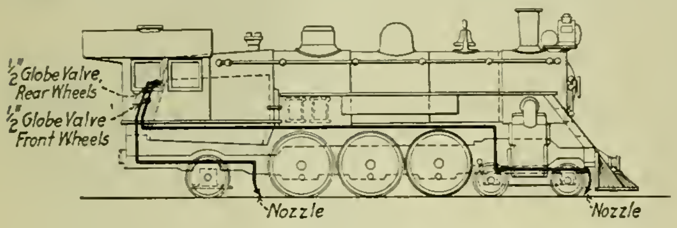


Fig. 1—Application of Rail Washer to Locomotive

The El Paso & Southwestern has had on some of its locomotives for several years (practically all being now equipped) a type of rail washer. This is a device, patented by J. M. Riddle, engineman, Alamogordo, N. M., using hot water from the boiler, which not only serves to lubricate the wheel flanges and rail, but, as the name implies, serves also to wash or remove sand from the rail after the drivers have passed over. Its application to a locomotive is shown in outline in Fig. 1. A ½ in. pipe is tapped into the back head of the boiler several inches below the water line and two pipes branch off from this main connection, one leading just ahead of the front engine truck and the other back of the rear drivers. These pipes are extended to within about 6 in. of the rail on either side of the locomotive and have small cast iron nozzles, shown in Fig. 2, at the end of each. On locomotives having trailers, the pipes to the rear wheels are applied just ahead of the trailers with the nozzles pointing slightly forward.

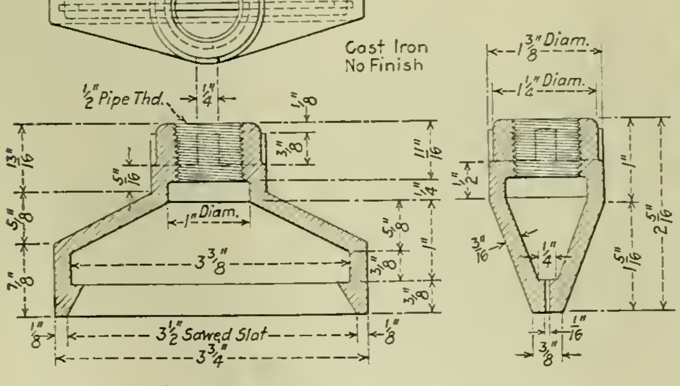


Fig. 2—Cast Iron Rail Washer Nozzle

The main connection to the boiler and each branch pipe therefrom are provided with valves accessible to the engineer which may be opened or closed at will, depending upon whether water is to be applied ahead of or behind the drivers. The main valve consists of an ordinary globe valve having not more than a ¼ in. opening into the boiler. A larger hole produces too great a pressure of water against the rail and is likely to blow out the flexible hose connection at the engine truck. Hot water thus applied not only serves as a lubricant between the wheel flanges and rails, but also neutralizes the effect of a frosty rail. It is said that on some of the grades of the E. P. & S. W. the use of this rail washer has made it unnecessary to double-head trains going over a grade and on branch lines, where curves are numerous, flange wear is reduced to a minimum and there is less danger of derailment. The device is said to be inexpensive to apply and maintain.

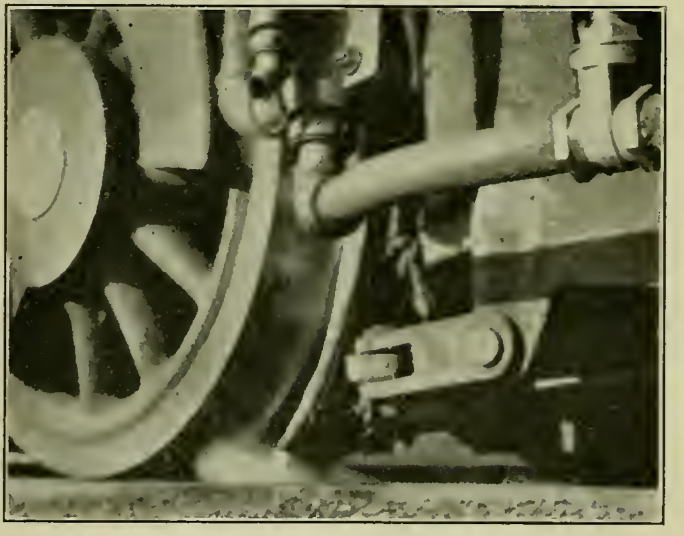


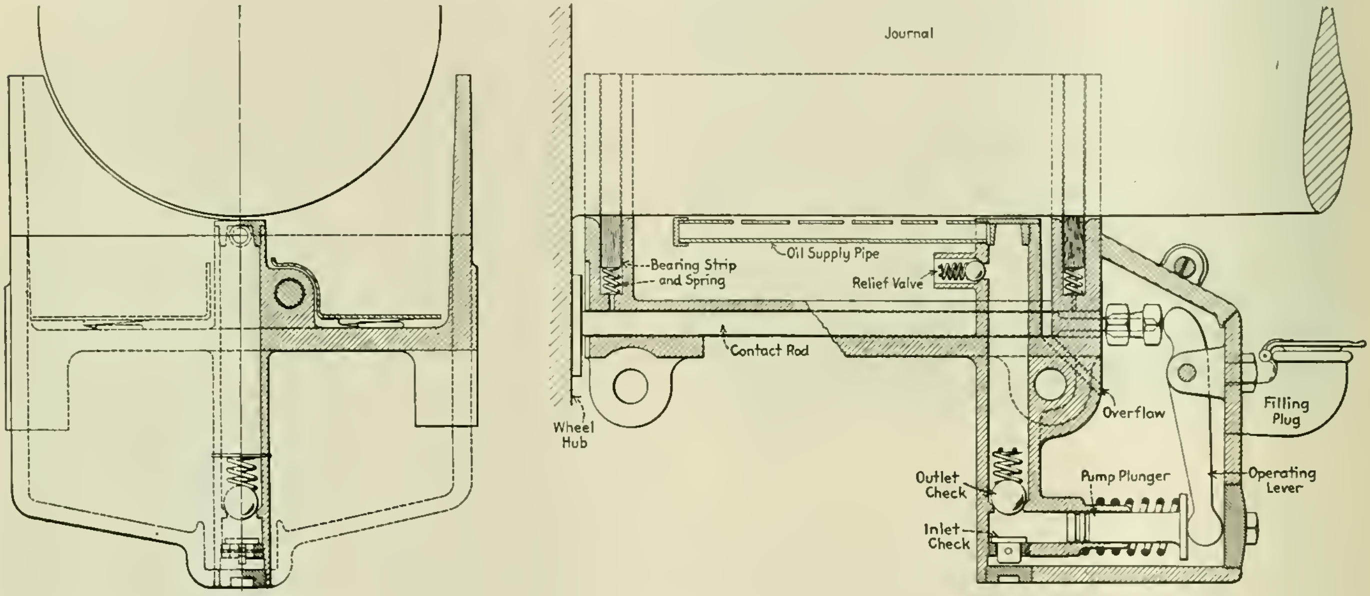
Fig. 3—Rail Washing Device in Operation

Hot water is used because it cuts the grease or frost from the rail more readily than cold water and is more conveniently taken from the boiler than from the tank. The patent, however, covers the taking of water from the boiler, injector or tank. In actual practice, the water consumption is about 85 gals. per hour, this being in the most severe service where the grade is continuous and curves numerous.

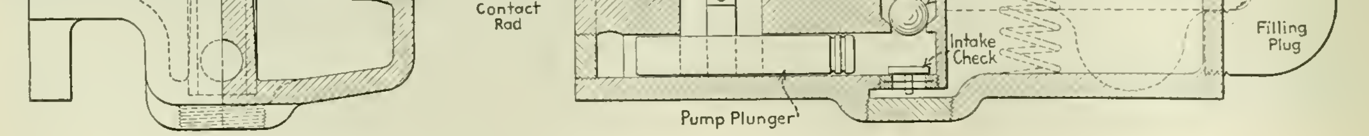
In such service the rail washers back of the rear drivers would be in operation practically all the time, washing sand from the rail, and the washers in front of the engine truck would be in operation when approaching and on curves. When using 85 gals. of water per hour, the coal consumption is about 118 lb., but in ordinary service 10 per cent of this amount is said to be sufficient. The comparatively slight cost of additional coal is felt to be unimportant in consideration of the greater tonnage that can be handled and the saving in flange and rail wear.

A Positive Mechanical Journal Lubricator

Owing to increased journal loads, speed requirements and extreme temperature variations in some parts of the country, present methods of lubricating the journals of railway equipment sometimes prove more or less inadequate. It is generally conceded that they have not kept pace with other improvements in equipment design. The amount of oil fed to high duty journals by capillary attraction through waste is insufficient and the direct results are costly hot boxes, delays and repairs to equipment. Contrary to the usual experience with car journals, locomotive driving journals lubricated with hard grease seldom become hot (at least hot enough to cut or score). This is because main bearings receive the personal attention of enginemen, and hard grease lubricates at a high temperature. The trouble is that hard grease does not begin to lubricate effectively until the journals become warm, and there is excessive friction.



Lubricator Arrangement as Applied to the Journals of Main Driving Wheels



Cross Section Showing Operation of Hennessy Engine Truck Journal Lubricator

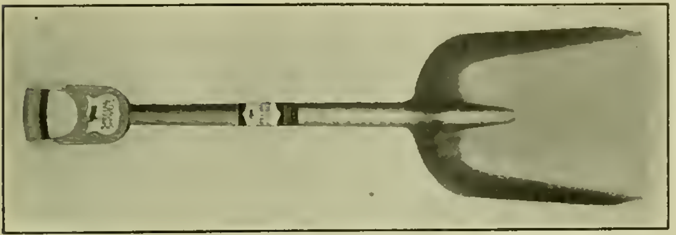
The result of lubricating journal bearings with too light oil or too heavy grease is unnecessary friction, power loss, rapid wear of journals and bearings and consequent deterioration of other moving parts. Important economies in labor, material and reduced equipment delays would immediately result from delivering oil of a proper consistency (from a lubrication standpoint and not from a standpoint of its ability to feed through waste) to the journals. This oil should be delivered at all times and in a predetermined quantity regardless of atmospheric conditions by positive, reliable, mechanical means.

Lubricators designed to accomplish these results have been developed by the Hennessy Lubricator Company, New York, being made in four styles for use with locomotive trailer, driver and truck wheels; also car wheels. Advantages claimed for these lubricators are that they are cheap, fool proof, have few parts and are easily applied, displacing the regular cellars without change or addition to bearings, journals or boxes. The lubricators are packed with waste in the regular manner and can be applied in roundhouses by regular forces. Pumping action is obtained from lateral wheel movement which is positive and regular. The waste is kept in contact with the journals by means of loose plates and springs and oil, being pumped up through to the journals, prevents the waste from glazing. The waste, in addition to distributing oil over the faces of the journals, is also a safety feature in the event of the pump becoming inoperative for any reason. Being always saturated with oil, the waste will continue to lubricate the journals, heating gradually and finally smoking, if a hot box develops.

Tests of Hennessy lubricators on lead trucks have demonstrated that about five times the ordinary mileage is made with a given quantity of oil. While it is recommended that the lubricators be removed for inspection at intervals of about 90 days, some have been in service on the Norfolk & Western as long as 11 months without being taken down for any purpose. The only attention required is the filling or supplying of oil to the cellars about once a week, dependent upon the class of service. It is stated that oil of the consistency of vaseline can be pumped through the lubricator if necessary.

Lightweight Shovel of Sturdy Construction

Recent improvements in shovel construction have been combined in a lightweight, rugged shovel made by the Conneaut Shovel Company, Conneaut, Ohio. It has long been the policy of this company to make special purpose shovels, and this new tool is made in two types and various sizes for molders and locomotive firemen. In both cases maximum wear and minimum weight are desired, and to serve this double purpose the shovel proper is made of molybdenum alloy steel. The steel scoop is rigidly fastened to a well-proportioned handle made of selected stock, the weights of the two shovels being made approximately 4 lb. and 5 lb., respectively. The hard service that a shovel must stand at the hands of molders and locomotive firemen is well understood and it is stated that severe tests have demonstrated the ability of the new Conneaut shovels to withstand any usage within reason. Any standard form of handle may be provided to suit the individual preferences of users.



Conneaut Special Firemen's Shovel Made of Molybdenum Steel

Ease of Operation Features New Coach Seat

One of the special features of a coach seat recently developed by the Scarritt Car Seat and Manufacturing Company, St. Louis, Mo., is freedom from jamming and ease of operation. This is secured by carrying the operating mechanism on four rollers, two on each side, operating in channels in the side plates, as shown in Fig. 1. The double automatic foot rest is designed to afford ample clearance for luggage beneath the seat, and, although it is mechanically operated, becomes inoperative when obstructed and allows the back to be reversed freely without injury to the seat mechanism or the obstructing baggage. The aisle arm is made of steel and can be enameled in any desired color and fitted with a wooden arm rest to match the finish of the car interior. The arm rest is firmly attached in place.

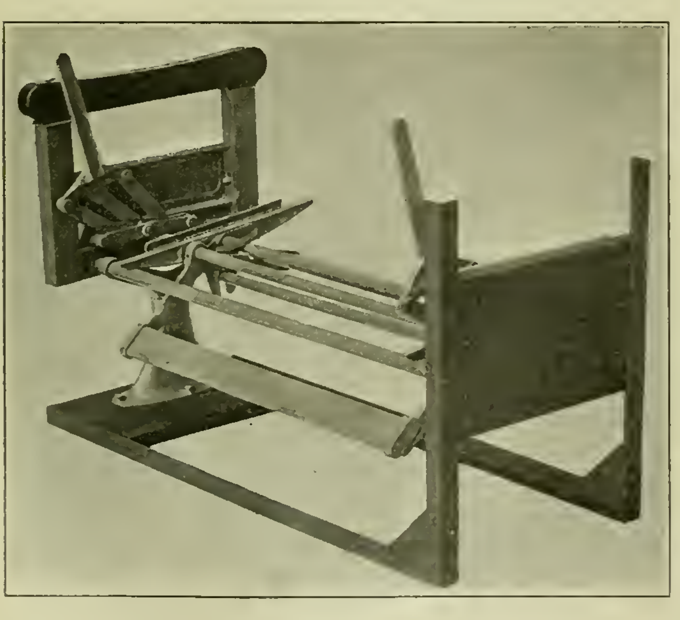


Fig. 1—View of Coach Seat Operating Mechanism

The seat can be equipped with any type of back cushion with or without a headroll. Fig. 2 shows the new type of back cushion with the Scarritt invisible headroll designed to afford maximum comfort to the passengers. The plush is applied without stitching and therefore can be renewed at a nominal labor cost, the elimination of all gimp and seams making this a most sanitary type of cushion. The seat cushion is of the full spring type with flexible edges and is designed to meet the most severe service conditions. The hand-stitched upper edge of the curled hair assures maximum life from the plush or other covering material. This seat was designed for first-class coaches and conforms to modern ideas of maximum comfort and durability in car equipment.

Fig. 2—Scarritt Coach Seat with Parts Assembled

Automatic Exhaust Pipe and Blower Valve

On page 358 of the June, 1920, *Railway Mechanical Engineer* there appeared a description of an exhaust pipe invented by J. E. Osmer, superintendent of motive power of the Ann Arbor at Owosso, Mich. Recent improvements, made in this exhaust pipe, have demonstrated their value on the Detroit & Mackinac and the Ann Arbor and are protected by patents pending. The illustration (Fig. 1) shows the exhaust pipe as adapted to Mallet engines. It will be noted that both passages are equipped with automatic acting valves, which open in response to fluid pressure. The source of the supply may be from the steam pipes to either the high or low pressure cylinders, as may be selected.

When the engineer opens the throttle, the two valves are raised from their seats. When the throttle is closed, both valves return to their seats, but not suddenly, as a ball check is incorporated in the steam passages leading to the space below the pressure plate so that a period of about one and one-half seconds is required for the valve to take its seat. The larger valve, around which all steam is exhausted into the stack when the locomotive is operating compound, is so constructed as to cause the discharge of exhaust steam in the form of a ring which completely fills the stack, thereby creating a more intense draft than can be obtained with the usual types of exhaust tips.

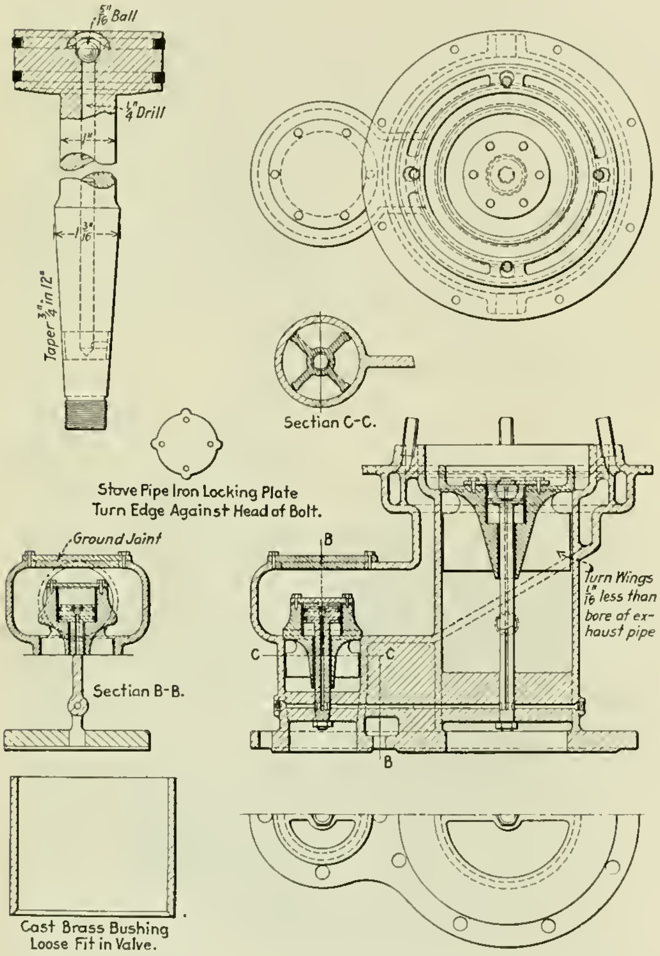


Fig. 1—Osmer Exhaust Pipe Adapted to Mallet Locomotive

The steel balls are incorporated also to perform an additional function. When the throttle is closed, permitting the locomotive to coast down a grade without the use of steam, drifting valve or vacuum relief valves are not needed. The valve may raise and lower in response to the amount of air drawn in through the cylinder cocks, and will close on the seat gently.

One important object of this automatic exhaust pipe is to prevent drawing gases and cinders from the smoke box into the cylinders, which not only destroys lubrication, but is severe on cylinder and piston rod packing, necessitating repairs and renewals. The device also tends to prevent the breaking of shoes and wedges, rod brasses, shearing of rod bolts, loose guide bolt nuts, and the pounding of either the high pressure or low pressure engines when descending a grade with the locomotive throttle entirely closed. In the entire construction careful attention was given to eliminating back pressure as much as possible, and at the same time increasing efficiency by exhausting steam in the form of a ring.

New Design of Blower Pipe

The Osmer exhaust pipe applied to a simple engine is shown in Fig. 2 together with a combination automatic and hand blower valve *F* which may be applied to an engine equipped with any kind of an exhaust pipe. As shown, the blower may be operated as usual from the cab, or by rod and bell crank connection to a miniature cylinder attached to the exhaust pipe. This cylinder contains a piston that responds to the pressure within the exhaust pipe and automatically shuts off the blower valve whenever the engine is exhausting steam.

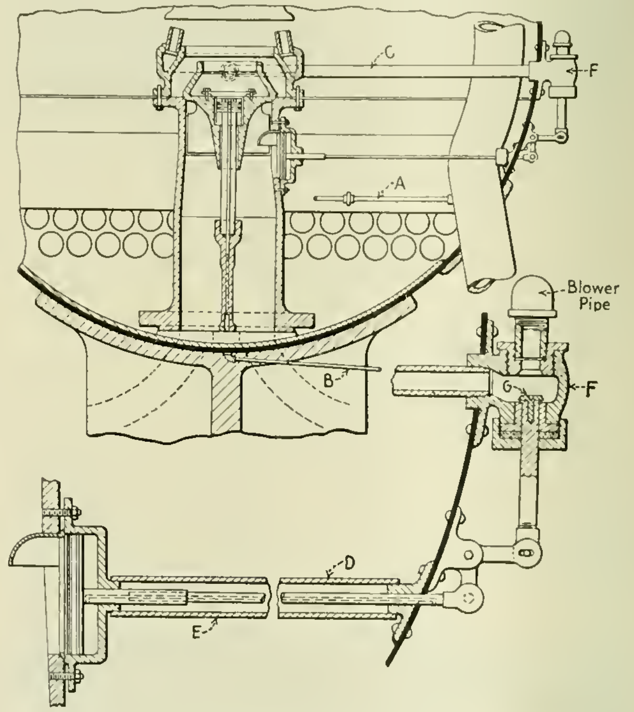


Fig. 2—Automatic Exhaust Pipe and Blower Valve as Applied to Simple Locomotive

Assuming that the blower valve on the boiler head is open, pressure would be delivered through the pipe and passed downward on valve *G*, forcing it from its seat and causing steam to pass through pipe *C* to the nozzle tip, and jets. When the engine is working, steam pressure within the exhaust pipe moves the piston to the right, and automatically closes the blower valve *G* against its seat.

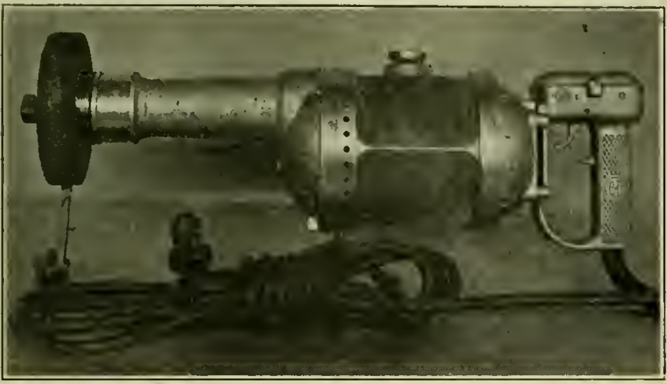
On suburban engines, firemen will regulate the valve on the boiler head to supply a jet of steam of sufficient force to carry off the smoke from the stack, and the moment the engineer closes the throttle, boiler pressure within the blower pipe will force the valve in the automatic valve from its seat and automatically apply the blower. On switch engines in districts where the smoke ordinance is severe, the automatic blower responds instantly to the closing of the throttle valve by the engineer.

Pipe *D* (Fig. 2) eliminates drawing dust particles into the stuffing box of the cylinder. Pipe *B* is a fluid pressure pipe, connected to the steam chest for actuating the exhaust pipe valve but pipe *A* is a preferable design, being tapped into the steam pipe with no outside piping. This is an advantage.

When it becomes necessary to repair or reface the valve and seat in the automatic blower valve, the union in the blower pipe immediately back of the automatic blower valve *F* is detached, and the brass bushing which forms the seat unscrewed. By the use of a ¼ in. bolt, valve *G* may be withdrawn from the stem, and after being faced, replaced without difficulty. The time and expense involved is small.

Portable Electric Grinder With Pistol Grip

The Black & Decker Manufacturing Company, Towson Heights, Baltimore, Md., has placed on the market recently a portable electric grinder equipped with a pistol grip and trigger switch. This arrangement adds to the convenience of operating the grinder which embodies most of the features included in standard Black & Decker drills. The operator has entire control over the grinder at all times and it is unnecessary to shift either hand to start or stop it.


Black & Decker Portable Electric Grinder Provided With Pistol Grip

While this grinder is essentially a portable machine it is supplied complete with an easily detachable base and adjustable tool rest so that it can be used with equal facility as a bench grinder. Besides the base, the equipment also includes two 5-in. by 1-in. grinding wheels (one fine and one coarse), a wire brush wheel and a rag buffing wheel. With these attachments the machine can be used for grinding, cleaning, buffing or miscellaneous polishing. Valuable features included in the grinder are grease lubrication throughout, forced air cooling, chrome nickel steel gears and shafts and aluminum alloy housing. The entire mechanism is protected from dust and other foreign matter. Owing to this form of construction the grinder is light and easy to handle. It may be operated on either direct or alternating currents at will, a ½-hp. motor being used operating at a speed of 3,200 r.p.m. The total weight when equipped with a 5-in. by 1-in. wheel is 21 lb.

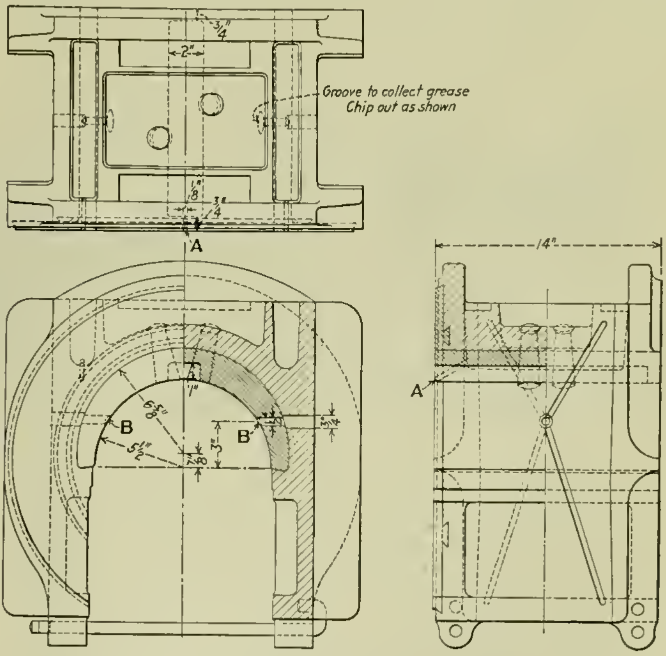
Driving Box Grease Groove Arrangement

On locomotive driving boxes having grease pockets located in the crown brasses on either side of the vertical center line, it frequently has been found necessary to bore out the crown and refit the brass to prevent the box from pounding. The maximum wear in the crown brass occurs on either side of the vertical center line and the top of the crown shows very slight wear.

A test has recently been completed using driving boxes with a grease groove arrangement patented by L. P. Ligon, master mechanic, Norfolk & Western, Roanoke, Va. As illustrated, the crown brass has a grease cavity in the top of the crown extending practically the full length of the bearing and approximately two inches wide. On the crown brass with a properly proportioned cavity it was found that as the brass wore it continued to fit the axle closely. The top portion, being cut away, allowed uniform vertical wear at the sides and top and pounding did not develop.

The cavity in the top of the crown wipes the surplus oil and grease from the axle and acts as a reservoir. To take full advantage of this reservoir, a slot *A* is cut through the crown from the grease cavity to the face next to the hub liner so that the grease can flow through and lubricate the hub liner. The location of this slot is such that the grease is applied to the hub liner at its smallest diameter next to the axle, and flows out over the entire face. This principle is also extended and holes *B* are drilled through the crown brass to the shoe and wedge faces through which the grease flows lubricating these surfaces.

After being in service 15 months the boxes tested were removed and examined. Very little wear had occurred and the fit of the crown brass and the axle was found in good condition. No lubrication was applied to these surfaces except that through the cavity in the crown brass. It was shown conclusively by the test that crown brasses with grease cavities in the tops of the crowns not only do not pound but provide ample lubrication for hub liners as well as shoe and wedge faces through holes or slots to these surfaces.



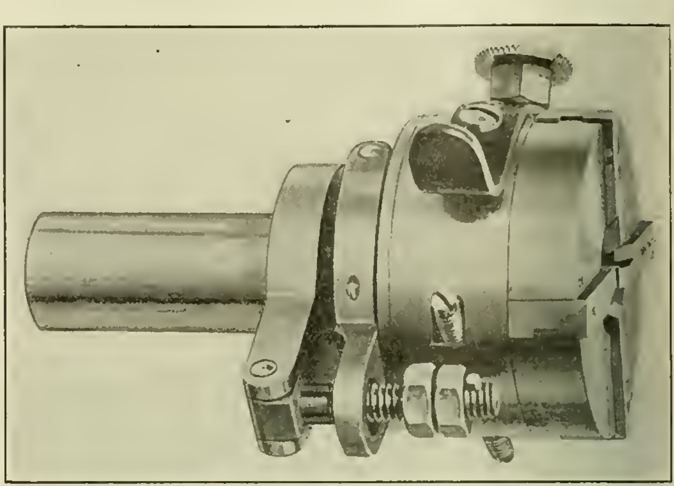
Grease Grooves Arranged to Lubricate Hub Face and Shoe and Wedge Ways

Self-Opening and Adjustable Die Heads

A NEW self-opening and adjustable die head, style DS, has been developed by the Geometric Tool Company, New Haven, Conn. This head was designed primarily for use on Brown & Sharpe automatic screw machines, but may be used on other automatics, rendering unnecessary any arrangement to reverse the spindle and back the die head off the threaded work. The head is of simple, compact construction and works independently of the turret feed, floating to suit the thread being cut. This prevents stripping and shaving the threads and makes the usual close camming of the machine unnecessary.

A lever trip is provided which reduces the force of tripping the die head and therefore lightens the reaction on the threads being cut. Buffer springs allow the head to yield slightly when the chasers come in contact with the work, insuring a smooth thread. Two check nuts on the side of the head provide easy adjustment of the point of tripping. A spring closing attachment eliminates as far as possible shock and wear, being located in a convenient position to strike a stop on the machine which automatically closes the die head when the turret revolves.

The chasers are of sturdy construction, having long bearings in the die head skeleton and are supported by hardened keys which prevent tilting and consequent cutting of taper threads. Four chasers are provided in each die head and the shanks are arranged to fit the particular size of machine on which they are used. These die heads are made in three sizes and have a capacity to cut threads from 1/16 in. to ¾ in. in diameter with pitches varying from 18 or finer to 10.



Geometric Self-Opening Die Head, Style D. S.

Franklin Precision Power Reverse Gear

UNUSUAL and interesting tests of the new Franklin Precision power reverse gear manufactured by the Franklin Railway Supply Company, Inc., New York, were made recently at Franklin, Pa. The object was to put the gear through tests that would duplicate locomotive service as nearly as possible and to subject it to conditions more severe than would occur on the locomotive itself. The specific purposes of the tests was to determine whether the piston would absorb valve motion shocks without moving, whether the gear would remain where set without creeping, whether the cut-off could be readily adjusted under load, whether the cut-off indicator and gear would work in synchronism, whether shock and stresses would be eliminated from the control going to the cab and whether the gear would automatically and instantly resist movement if an unbalanced load was suddenly applied.

To determine these points, special testing apparatus shown in Fig. 2 was constructed. The gear was secured to the frame in the same way in which it is applied to a locomotive. Application of the cab control wheel and operating rod was made in the same relative position as actual service requires and the cut-off indicator set at its proper relation to the gear. Compressed air at a pressure of 105 lb. per square inch was applied to the cylinder. A set of gages was attached to the cylinder compartment for pressure reading, bleed cocks being installed at each gage.

To subject the reverse gear to stresses similar to those received from the valve gear when a locomotive is running, an extended rod was attached to the gear piston rod. This rod passed through an adjustable friction clutch by means of which varying and very heavy resistances could be applied. To the friction clutch was attached a connecting rod which was operated by an eccentric with one inch travel, driven by an electric motor. The eccentric served to reciprocate the clutch on the extended piston rod, subjecting the gear to shock and reversal of stresses equaling those occurring in actual service.

Frictional resistance between the adjustable clutch and extended piston rod was obtained by tightening the clutch. These frictional resistances were calibrated by hanging known weights on a cable which passed over a pulley and was hooked on the extended piston rod. When the friction of the clutch stopped the weight from moving, the frictional resistance equalled the load on the cable. This weight ar-

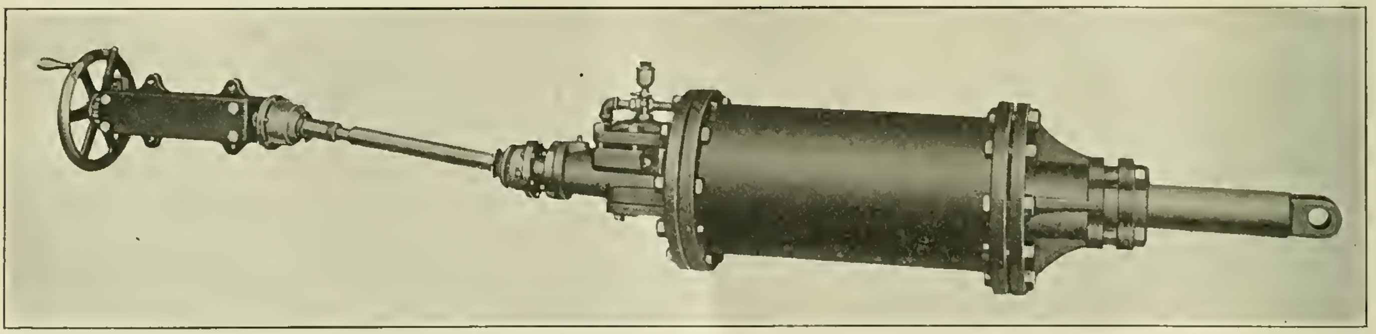


Fig. 1—Gear Assembled as Applied to the Locomotive

rangement was used to establish a known frictional resistance.

Two conditions were considered, the first where the force acting on the gear piston was the same in both directions, the second an unbalanced force acting in one direction only. In the first case the desired frictional resistance between the clutch and rod was obtained as outlined above, and the cable and weights were disconnected from the rod. The motor was then started and the clutch forced to travel back and forth on the piston rod 320 times per minute. Observations were taken on ten separate tests, each test being run without a stop for 30 minutes.

To duplicate the condition of an unbalanced force acting on the gear in one direction only, the frictional resistance of the clutch was first set to equal the weight hung on the rod and the weight not disconnected.

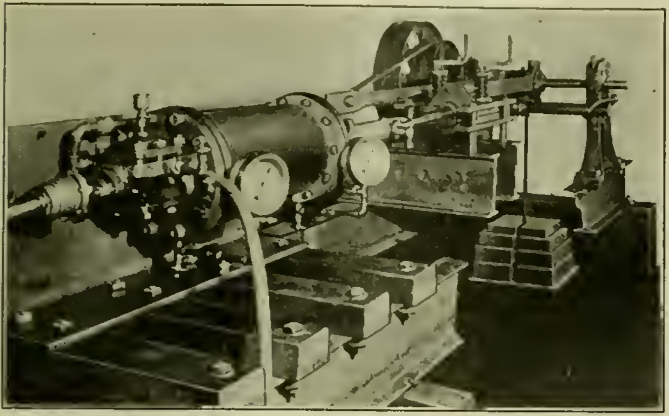


Fig. 2—Gear With Rod and Clutch Attached for Test

In starting these tests, observations were taken with no load on the gear in order to establish the position of the cab indicator relative to the actual point of cut-off. Moving the indicator from corner to corner and setting to any desired cut-off the relative positions of the indicator and piston checked in every case within 1/32 in.

Seven separate running tests were made with the clutch operating against the gear in each direction. The first test was run with 500 lb. frictional resistance between clutch and piston rod and the resistance was increased 500 lb. for each test until a load of 3,500 lb. was reached. With the motor reciprocating the clutch 320 times per minute, there was absolutely no movement of the piston. The gear was moved from corner to corner slowly or as rapidly as desired and the cut-off always checked with the position shown by the cab indicator. While under load, the force required to adjust the cut-off was so small that the operating rod could be rotated by hand without using the cab control wheel. The gear absorbed all shocks, no vibration or stresses being transmitted to the cab control wheel or indicator.

To demonstrate the operation in case of leaks, the pressure in the cylinder was bled down approximately 15 per cent. Under these conditions the piston moved .005 in. each way under load. When the leakage cock was closed the pressure automatically rose and stopped all movement of the piston.

To determine the effect of an unbalanced load in one direction only, the clutch was set for 2,000 lb. and weights left attached, the clutch and weight equaling 4,000 lb. one way and zero the other. Under these conditions the gear immediately set up the differential pressure in the cylinder required to absorb the shocks. There was no movement of the piston and bleeding of each cylinder compartment by hand had no effect.

To further unbalance the load the clutch pressure was increased to 2,500 lb., making a load of 5,000 lb. acting on the gear in one direction only. No movement of the gear was perceptible, the cut-off being held as rigidly as before.

Description of Gear

This power reverse gear, as its name implies, is designed for precise adjustment of cut-off. It consists of a 10 in. by 18 in. cylinder with all parts enclosed. It has ample strength for the heaviest work. The operating valve is attached to the rear end of the cylinder and is controlled by a hand wheel in the cab. This wheel is provided with an indicator showing the point of cut-off and is connected to the gear by an operating rod. This wheel and rod are relieved of all stresses or shocks in the functioning of the gear.

No crosshead or guide is used with this gear, the thrust being taken through the piston. Levers and rods have been eliminated and there are no pins or bushings to wear and affect the accuracy of cut-off. No adjustments are provided as none are required. Wearing parts have been reduced to the minimum. Steam can be used as a medium for operating the gear in emergencies.

The results of the tests described above show that the gear provides extremely accurate adjustment of cut-off and freedom from creeping. Pressure is automatically set up to resist sudden unbalanced forces and maintain stability of adjustment. All shocks from the valve gear are absorbed by the air in the gear cylinder. The design gives a low air consumption and provides adjustment of cut-off with minimum physical effort. When air is cut off, the gear remains positioned corresponding to the last adjustment and cannot be changed until air or steam is again used.

Long Distance Recording Thermometers

STURDINESS of design is a feature of the new thermometer made by the Brown Instrument Company, Philadelphia, Pa., to record temperatures at a distance. The thermometer can be furnished with tubing up to 150 ft. in length if required. Shorter lengths, however, are to be desired since the instrument is proportionately sensitive. The capillary tubing is protected by a reinforced flexible drawn tubing which can be stepped on without injury.

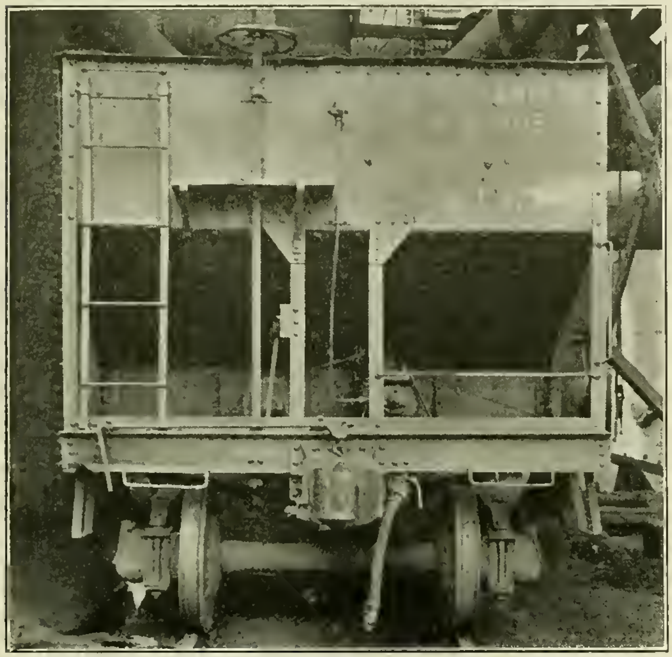
Bulbs have been developed to meet every requirement and are made of drawn copper tubing with a heavy coating of nickel. This nickel coating materially increases the resistance to oxidation.

Other important features are included in the design of the thermometer itself. By turning a knob, the pen can be set at the exact temperature without the necessity of bending the pen arm with the fingers. Another slight adjustment makes the pen bear more heavily or lightly on the paper. The pointer, setting device and actuating spring are assembled in a compact, reliable unit. A patented method for calibrating the instrument is supplied. The pen arm lifts when the door is open and is replaced automatically on the paper when the door is closed. A Seth Thomas clock is used to provide the clock movement. Another feature is the inverted pen which prevents ink from running down and corroding the pen arm. The entire mechanism is enclosed in a dust and moisture proof case.

One of the uses for which this recording thermometer should prove particularly valuable is the measuring and recording of superheated steam temperatures in stationary power plants. The accurate control of superheated steam temperature is essential to efficient boiler operation and this control is only possible by use of temperature recorders.

Safety Hand Brake Stands Severe Tests

A NEW design of safety hand brake, made by the Minich Railway Appliance Corporation, Philadelphia, Pa., has been tested recently under severe service conditions and reported on favorably by the Interstate Commerce Commission. The brake consists of a vertical shaft, similar to those in common use, and attached as usual to the end of the car. The bottom of the shaft, however, is supported by a special cage casting, and is threaded to take a nut which is guided by slots in the cage. The nut moves vertically up and down, depending on which way the staff is revolved. On opposite sides of the nut are lugs forming trunnions by which a U-shaped lever is operated. The usual brake chain, or air brake lever in the case of hopper cars is replaced by a connecting rod. Round lugs on opposite sides of the cage serve as a fulcrum for the U-lever so that when the staff is revolved and the nut raised, the lever revolves on these lugs and tends to change from an approximately horizontal to a vertical position, thus pulling up and applying the brakes through the rigging in common use. The fulcrum of the U-lever changes so that the power is comparatively low at the beginning, permitting the slack to be taken up quickly, but resulting in an increase of leverage and power towards the end of the application. No pawl is necessary to hold the brakes applied, since they can be released only by turning the staff in the opposite direction.


Hopper Car Provided with Minich Safety Hand Brake Equipment

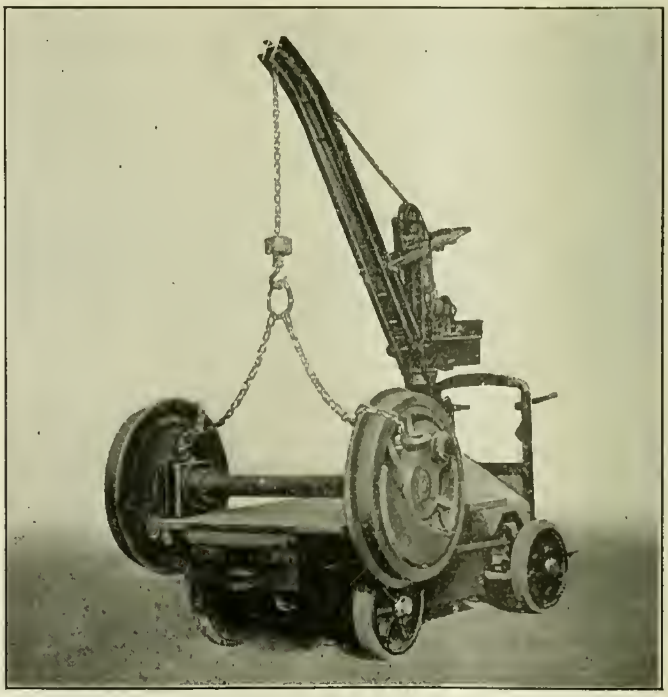
It is maintained that this brake is an important safety device, being more efficient, inexpensive and easier to operate than the familiar ratchet and pawl type. The brake holds where applied and is not released partly to allow a pawl to engage, consequently all the energy is maintained and not lost when most needed. The brake is said to be three times as powerful as an ordinary brake and this without the use of a brake stick. Ratchet, pawl and brake chain are eliminated. It is stated that cars can be controlled accurately and easily on down grades, accidents being prevented by eliminating danger of sudden releases. All stress on the staff is vertical, therefore the parts will not be frequently bent and forced out of alinement. Owing to the use of few parts and a short, light staff, it is easy to install and maintain the brake.

Storage Battery Truck Equipped with Crane

STORAGE battery trucks have demonstrated their ability as labor saving devices in railroad shops and storerooms and many of these trucks are now equipped with devices to facilitate loading and unloading. To eliminate manual labor as much as possible the Yale & Towne Mfg. Co., Stamford, Conn., has developed the crane-equipped truck, illustrated, with a total load carrying capacity of 4,000 lb. It can be run at speeds up to 6 miles an hour loaded, negotiating grades up to 12 per cent, and running over any road that presents a reasonably smooth surface. It does not need to be jockeyed into position before lifting the load, which may be picked up by the crane from either side of the truck or from the end, since both the boom and load chain may be raised simultaneously, thus lengthening or shortening the out-reach of the boom as required. The crane has a total capacity of 1,600 lb. at the maximum out-reach position of 69½ in. from the center line of the mast. This load capacity increases as the out-reach decreases until at a distance of 24 in. the crane will pick up 1,900 lb.

The truck illustrated has been subjected to severe tests, it is said, with satisfactory results, and experiments are now being carried on at the plant with the idea of equipping the truck with an electro-magnet and dump body. The dump body will be especially valuable for use in picking up and handling quickly scrap metal. The assembled wheels and axles, shown in the illustration, weigh approximately 1,800 lb. and it would require considerable effort on the part of two or possibly four men to roll these wheels onto the truck without the crane.

The truck is equipped with a storage battery operating both truck driving mechanism and crane mechanism. The weight of the truck complete ready for shipment is 3,200 lb.


Yale & Towne Crane-Equipped Truck Carrying Small Driving Wheels

Railway Mechanical Engineer

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with which the AMERICAN ENGINEER *was incorporated*)

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WE GUARANTEE, that of this issue 8,800 copies were printed; that of these 8,800 copies 7,719 were mailed to regular paid subscribers; 8 were provided for counter and news company sales; 251 were mailed to advertisers; 32 were mailed to employees and correspondents and 790 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 67,500, an average of 9,643 copies a week.

The *Railway Mechanical Engineer* is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.)

A fire at the roundhouse of the Boston & Maine, Portsmouth, N. H., on June 20, damaged the building and several locomotives at a total estimated loss of $150,000.

The Baltimore & Ohio has consolidated the Ohio river and the Wheeling divisions, making Wheeling, W. Va., the headquarters and discontinuing the offices at Parkersburg. On the Indiana division, Seymour, Ind., has been abandoned as a freight terminal and North Vernon is to be the terminal instead.

The Mechanical Division of the American Railway Association has issued a supplement to the 1920 Rules of Interchange, prepared by the Arbitration Committee. This supplement includes corrections to the rules, several additional interpretations rendered by the committee, and a few changes which have been made to clarify the rules.

The Chicago Chapter of the American Society for Steel Treating has elected the following officers: Chairman, H. M. Wood, Ingalls-Shepard division, Wyman Gordon Company, Harvey, Ill.; vice-chairman, T. A. Lovegren, Standard Forging Company, Indiana Harbor, Ind.; secretary-treasurer, Harry Blumberg, Illinois Steel Company.

The Missouri-Illinois Railroad on June 1 opened its entire line for business. The line of this company, which is the successor of the Illinois Southern, extends from Salem, Ill., southwest to Kellogg, on the Mississippi River, and from St. Genevieve, Mo., southwest to Bismarck, a total distance of 127 miles, with a branch from Collins, Ill., south, to Chester, 11 miles.

The new classification of railroad employees and rules for reporting their number and compensation announced some time ago by the Railroad Labor Board has been completed and issued in book form to the carriers. The employees are divided into approximately 148 classes, which in turn have been subdivided so that there are approximately 500 distinctive classes created.

Honorary Degrees

At the commencement exercises at Williams College, Williamstown, Mass., on June 20, the honorary degree of doctor of laws was conferred on Edgar E. Clark, chairman of the Interstate Commerce Commission.

At the commencement exercises at Tufts College, Medford, Mass., on June 20, the honorary degree of master of arts was conferred on Samuel O. Dunn, editor of the *Railway Age*.

Mechanical Division Scholarships

Three vacancies occurred in June, 1921, in the scholarships awarded to sons of railroad men or others with experience in the mechanical department and administered through the Mechanical Division of the American Railway Association. Two of the vacancies are in the scholarships at Stevens Institute of Technology and the third is one of the Joseph T. Ryerson & Son's scholarships which provides for a four-year course at universities elected by the American Railway Association. Application for these scholarships can be made through V. R. Hawthorne, secretary of the Mechanical Division.

Locomotives

THE ERIE RAILROAD has bought from the Surplus Property Division of the War Department 45 of the Decapod locomotives originally built for the Russian government. These constitute the remainder of the Decapods held by the government.

Freight Cars

THE PITTSBURGH & WEST VIRGINIA has ordered 300 hopper car bodies of 55 tons' capacity from the Cambria Steel Company.

THE ERIE RAILROAD will have repairs to 1,000 box cars of 40 tons capacity made at the Hammond shops of the Standard Steel Car Company.

The GREAT NORTHERN has ordered 500 refrigerator cars from the General American Car Company. These cars are to have wooden underframes.

THE MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE has awarded a contract to the American Car & Foundry Company, for the repair of 500 box cars.

MITSUI & CO., New York, has ordered 40 air dump cars for the South Manchurian Railway from the Kilbourne & Jacobs Manufacturing Company. These cars are to be of 20 cu. yd. capacity.

THE UNION PACIFIC has given an order to the Pacific Car & Foundry Company for repairs to 1,000 box cars. The work is to be carried out at the Portland plant of the Pacific Car & Foundry Company.

Shop Construction

THE ILLINOIS CENTRAL has awarded a contract for an extension to its roundhouse at Paducah, Ky., to the Ellington-Miller Company, Chicago, at a cost of approximately $15,000. This company has also awarded a contract for the construction of additions to its roundhouse at Waterloo, Iowa, to W. J. Zitterall, Webster City, Iowa.

THE LOUISVILLE & NASHVILLE has awarded contracts to Joseph E. Nelson & Sons, Chicago, in connection with improvements to its terminal at Hazard, Ky., for the construction of a roundhouse, machine shop, oil storage building, car department building, storage and office building, lavatory building, and an engineers' locker and register building. The total cost of the project is approximately $180,000.

A. R. A. Mechanical Division Meeting Postponed Indefinitely

The postponed meeting of the Mechanical Division, American Railway Association, which was to have been held at the Blackstone Hotel, Chicago, on Wednesday and Thursday, June 29 and 30, has again been postponed as announced in a circular issued by the Mechanical Division on June 21. In view of the uncertainty as to conditions for the next few weeks no date has been set for the postponed meeting.

MEETINGS AND CONVENTIONS

The *Chief Interchange Car Inspectors' and Car Foremen's Association* convention for this year has been postponed.

The *American Railway Tool Foremen's Association* convention which was to have been held at the Hotel Sherman, Chicago, on August 9, 10 and 11, has been postponed.

The *International Railroad Master Blacksmiths' Association* convention which was to have been held at the Hotel Sherman, Chicago, on August 16, 17 and 18, has been postponed.

The *International Railway General Foremen's Association* has decided to cancel its 1921 convention which was to have been held September 12, 13, 14 and 15 at the Hotel Sherman, Chicago, owing to the financial stress and serious business conditions.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

Division V—Equipment Painting Division.—V. R. Hawthorne, Chicago.

American Railway Association, Division VI—Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamlin Ave., Chicago. Convention September 12-14, Hotel Sherman, Chicago, Ill.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Society for Steel Treating.—W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention September 19-24, Indianapolis, Ind.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Meeting second Tuesday of each month except June, July and August, at Windsor Hotel, Montreal.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago. Ill. Meeting second Monday in month, except June, July and August, New Morrison Hotel, Chicago, Ill.

Car Foremen's Association of St. Louis.—Thomas B. Koencke, 604 Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 95 Liberty St., New York, N. Y.

Chief Interchange Car Inspectors and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Meeting second Tuesday of February, May, September and November, at Hotel Sinton, Cincinnati.

Dixie Air Brake Club.—E. F. O'Connor, 10 West Grace St., Richmond, Va.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 715 Clarke Ave., Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York, N. Y.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Meeting second Tuesday of each month, except June, July, August and September.

New York Railroad Club.—H. D. Vought, 95 Liberty St., New York, N. Y.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Meeting second Friday of each month, except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Meeting third Monday of each month, except June, July and August.

PERSONAL MENTION

GENERAL

C. M. Hoffman, superintendent of machinery of the Verde Tunnel & Smelter railroad, with headquarters at Clarkdale, Ariz., has been appointed superintendent motive power and machinery of the Los Angeles & Salt Lake, with headquarters at Los Angeles, Cal., succeeding D. P. Kellogg, who has resigned.

F. D. Wildrick, chief clerk to the mechanical superintendent of the New York Terminal Region of the Erie, has been appointed office manager of all offices in the mechanical department of the New York Terminal Region. Mr. Wildrick's headquarters will be at Jersey City, N. J.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

J. Jones has been made locomotive foreman of the Canadian Pacific at MacTier, Ont., vice J. J. Dey, transferred.

F. T. Knight, locomotive foreman of the Canadian National Railways at Port Arthur, Ont., has been appointed locomotive foreman of the Grand Trunk Pacific at Sioux Lookout, Ont., succeeding W. H. Fletcher, transferred.

E. J. McSweeney, division master mechanic of the Baltimore & Ohio with headquarters at Washington, Ind., has been transferred to Garrett, Ind., succeeding W. F. Moran, resigned. C. M. Newman succeeds Mr. McSweeney.

C. C. Reynolds has been made road foreman of engines of the Santa Fe at Redondo Junction, Cal., succeeding F. A. Gibbs.

SHOP AND ENGINEHOUSE

Harry E. Wells has been made general foreman of the Atchison, Topeka & Santa Fe, at Marceline, Mo., succeeding J. Banker, retired.

PURCHASING AND STORES

Ernest O. Cook has been made storekeeper of the Santa Fe at Riverbank, Cal.

John E. Mahaney, whose appointment as superintendent of stores of the Chesapeake & Ohio was announced in the June issue of the *Railway Mechanical Engineer*, was born at St. Paul, Minn., December 23, 1879, and entered railway service in the stores department of the Minneapolis, St. Paul & Sault Ste. Marie at Minneapolis in 1895. In 1900 he went with the Eastern Minnesota (Great Northern) as general foreman. From 1903 to 1906 he served the Chicago, Rock Island & Pacific in a similar capacity. He then served the Southern Pacific as storekeeper, leaving that position in 1910 to become general storekeeper of the Oregon-Washington Railroad & Navigation Company. In 1913 he went with the Spokane, Portland & Seattle as general purchasing agent and general storekeeper. Two years later he became general storekeeper of the Norfolk Southern. During federal control Mr. Mahaney served the Procurement section, Railroad Administration, as supervisor of stores of the Northwestern region. On May 1, 1919, he returned to the Norfolk Southern as general storekeeper, which position he held at the time of his recent appointment.

OBITUARY

Robert Kennedy Reading, who served as superintendent of the Pennsylvania Railroad at Williamsport, Buffalo and Altoona, died very suddenly at Williamsport, Pa. Mr. Reading was for about 40 years in the employ of the Pennsylvania.

Portraits on Tickets.—The New York Central announces that buyers of commutation tickets, for use between New York City and certain points 50 miles or more from the city, are to be required to furnish a photograph, to be pasted on the ticket; this to prevent misuse of tickets, which has become common. On the Hudson division this order applies to Beacon and Poughkeepsie; on the Harlem division to Towners and Patterson, and on the River division to Newburgh.

SUPPLY TRADE NOTES

The Standard Pressed Steel Company has removed its headquarters from Philadelphia to Jenkintown, Pa.

The Canton Foundry & Machine Company, Canton, Ohio, has removed its New York City office from the Grand Central Palace to 45 West Eighteenth street.

The American Flexible Bolt Company removed its sales offices on June 1 from 50 Church street to the Liggett building, Forty-second street and Madison avenue, New York City.

The Steel Fabricating Corporation recently completed its new works and general offices at Michigan City, Ind., and has removed its executive headquarters from Harvey, Ill., to Michigan City.

The Canadian Locomotive Company, Ltd., Kingston, Ontario, is carrying out improvements at its shops, to include two additional pits to the erecting shop and the construction of a storage building 200 ft. by 75 ft.

Max Grant, manager of technical railway sales of the Glidden Company, Cleveland, Ohio, has left the service of that company to become manager of the railway paint department of the Acorn Refining Company, Cleveland.

The Dressel Manufacturing Corporation, New York, has established an office in the Railway Exchange, Chicago, under the supervision of De F. Lillis, who for many years was connected with the motive power department.

P. R. Letts has been appointed office manager of the industrial bearings division of the Hyatt Roller Bearing Company, New York, succeeding G. J. Traendly, who is now office manager of the General Motors Corporation, New York.

E. J. Floor has been appointed district sales manager of the Page Steel & Wire Company at 208 South La Salle street, Chicago, succeeding W. R. Bleecker, Jr., who has been transferred to the New York office of the company.

M. E. Lisle, assistant to the president of the Terminal Engineering Company, Inc., 17 West Forty-fourth street, New York City, has been elected vice-president and M. E. Peck, office manager, has been elected secretary and assistant treasurer.

The Combustion Engineering Corporation, 43 Broad street, New York, has removed its Philadelphia, Pa., branch office from 1112 Lincoln building to the tenth floor of the Finance building. This territory is under the management of W. C. Strips.

C. W. Cross has been appointed railroad representative of the Torchweld Equipment Company, Fulton and Carpenter streets, Chicago. Mr. Cross was until June 1, manager of western railroad sales for the Chicago Pneumatic Tool Company.

The Vacuum Oil Company, 61 Broadway, New York City, has opened new branch offices at Buffalo, N. Y., and Dallas, Tex. The Buffalo office will cover New York State west of the Hudson river and the Dallas office the states of Texas and Oklahoma.

The Geometric Tool Company, New Haven, Conn., manufacturers of screw thread cutting and tapping tools, have taken over the exclusive sale of high speed tapping devices, quick change chucks and collets and combination tapping devices equipped with quick change chucks, manufactured by the Charles L. Jarvis Company, Gildersleeve, Conn.

William Archie Kyte, sales manager and a member of the board of governors of the Foster Machine Company, died on May 24 at his home in Elkhart, Ind. Mr. Kyte was born at Middlebury, Ind., on March 1, 1878, and his association with the Foster Machine Company started in 1905. His death was caused by nervous exhaustion and heart trouble, after an illness dating from last January.

The Link-Belt Company, Chicago, has acquired all of the capital stock of the H. W. Caldwell & Son Company, Chicago, and Frank C. Caldwell has been elected a director of the Link-Belt Company. The Caldwell Company's plant will continue to operate under separate corporate existence, under its present name, and the plant management will remain substantially the same as heretofore.

Karl G. Roebling, president of John A. Roebling's Sons Company, Trenton, N. J., died at Springlake, N. J., on May 29, while playing golf. He was born at Trenton in 1873. Mr. Roebling was graduated from Lawrenceville school and from Princeton University in the class of 1894. He went with the Roebling company immediately after graduation and in 1918 was elected president of the company.

The Master Tool Company, 20 East St. Clair avenue, Cleveland, Ohio, has been organized under the laws of Ohio to manufacture a new line of pneumatic tools, and will specialize in the reclaiming of all types and makes of same. The officers of the company are: J. Nightingale, president; Charles F. Overly, vice-president and general manager; William Eckert, secretary-treasurer. C. F. Overly is manager of sales.

The Elliott Company, Jeannette, Pa., announces the following changes in its sales organization: R. H. Schmidt goes to the St. Louis district office, W. E. Widau to the Cleveland office, and R. S. Bellman to the Philadelphia district office. In addition to the Elliott Company's products, they will also handle those of the Lagonda Manufacturing Company, Springfield, Ohio, and the Liberty Manufacturing Company, Pittsburgh, Pa.

Alexis I. du Pont, secretary and director of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., died on May 30, at Wilmington after an illness of ten days. He was born in Wilmington in 1869, and graduated from Harvard in 1892. After graduation he took up work with the du Pont company, and had long been associated with the other members of his family in many of the large undertakings connected with their name.

Harry W. Torney, of Torney & Co., New York, was recently elected president of the Sharon Pressed Steel Company, with office at 66 Broadway, New York City. This company was recently reorganized. Arthur W. Swan is now general manager in charge of manufacture; he was formerly chief engineer and works manager of the Crucible Steel Company and its associates. J. G. White has been appointed district sales manager at Detroit, Mich. The company recently installed some new machinery at its plant, Sharon, Pa.

Charles A. Kothe has been appointed mechanical superintendent of the American Automatic Connector Company, Cleveland, Ohio, succeeding N. M. Barker, resigned. Mr. Kothe in 1900 entered the service of the Erie Railroad as a machinist and subsequently served in various positions at different places until 1913, when he was promoted to master mechanic at Marion, Ohio. He subsequently was transferred in the same capacity to Port Jervis, N. Y., and from 1919 served as general inspector at Youngstown, Ohio, until his recent appointment with the American Automatic Connector Company.

Colonel Washington A. Roebling, for many years vice-president of John A. Roebling's Sons Company, Trenton, N. J., has been elected president, to succeed his nephew, Karl G. Roebling. Colonel Roebling, who is 84 years old, was engaged with his father, John A. Roebling, in building the suspension bridge over the Allegheny river at Pittsburgh, and the Cincinnati and Covington suspension bridge. With his brother, Charles G. Roebling, he successfully carried out the work of completing the Brooklyn bridge, the construction of which devolved upon them after the death of their father in July, 1869.

The directors of the Greenfield Tap & Die Corporation, Greenfield, Mass., on June 9, voted to purchase the entire capital stock of the Greenfield Machine Company, Greenfield, manufacturers of cylindrical and universal grinders, and the Morgan Grinder Company, Worcester, manufacturers of internal grinders. This combination, together with the machines now produced by the Greenfield Tap & Die Corporation, will constitute the machine division of the Greenfield Tap & Die Corporation. The operation and organization of both plants will remain the same for the present, although eventually the Worcester plant will be moved to Greenfield.

Henry T. Gerdes, mechanical engineer and manufacturer, of New York, has been elected president of the Hauck Manufacturing Company, Brooklyn, N. Y., maker of oil burners, oil forges, oil burning appliances, etc. The other officers of the company are: M. C. Hauck, first vice-president; A. B. Hauck, second vice-president; H. H. Kress, third vice-president; A. H. Stein, treasurer, and J. Lutz, secretary. Mr. Gerdes, who succeeds the late Arthur E. Hauck as president, is a graduate of Stevens Institute of Technology. He was for many years manager of the Treadwell Engineering Company, Easton, Pa., and has a practical knowledge of the manufacture of oil burning torches and appliances.

William Jordan Caton, secretary of the Burden Iron Company, Railroad and Steamship Division, and assistant to the president of the Sanitation & Supply Company, New York, died on June 17, in the Harbor Hospital, Bath Beach, Brooklyn, N. Y., at the age of 66. He began railway work in the auditor's department of the Boston & Albany at Springfield, Mass., and subsequently served in the passenger department of the same road. He was later purchasing agent of the Pittsburgh & Lake Erie. He served for about nine years as New York representative of Brown & Co., Inc., Pittsburgh, Pa., until July, 1920, when he left the service of that company to go to the Burden Iron Company, Railroad and Steamship Division.

Charles Hosmer Morse, chairman of the board of directors of Fairbanks, Morse & Co., Chicago, died on May 5, at his home in Winter Park, Fla. He was born in St. Johnsbury, Vt., on September 23, 1833, and received his education at St. Johnsbury Academy. Mr. Morse began his business career in 1850, as a clerk in the office of E. & T. Fairbanks & Co., scale manufacturers. In 1862, he became a member of the firm of Fairbanks, Greenleaf & Co., Chicago, successors to E. & T. Fairbanks & Co., and on January 1, 1872, when the firm of Fairbanks, Morse & Co. was established, he became president of that company. He retired as president on May 19, 1915, to become chairman of the board of directors of the same company, at which time he was succeeded as president by his son, C. H. Morse, Jr.

The Manufacturers Exhibition Company, Inc., has established a permanent world market for machinery in the building occupying the block on Sixth avenue, Eighteenth street and Nineteenth street. New York City. The company's plans are broad in scope, including American and international promotion of the sale of all American manufactured mechanical products. There are exhibits of machinery of all kinds and many of the exhibitors have their own representatives in the market, but those who have no one present are represented by trained technicians who will conduct the buyers through the exhibits, explaining all points desired. L. R. Duffield, who was general manager of the Philadelphia Bourse for over ten years and recently general manager of the International Exposition of Industries, is president and general manager of the Manufacturers Exhibition Company, Inc.

George Jesse Foran, for many years manager of the condenser department of the Worthington Pump & Machinery Corporation, New York, died on May 12, at his home in New York City. He was born on January 22, 1862, in Boston, Mass., and graduated from the Massachusetts Institute of Technology in May, 1883, in the department of mechanical engineering, with the degree of bachelor of science. The following September he entered the employ of the Deane Steam Pump Company, Holyoke, Mass., and shortly afterwards was transferred to the Boston office of that company. In November, 1886, he went with the George F. Blake Manufacturing Company as a salesman, and later served also as consulting engineer to the president and treasurer of the Blake company. From 1890 to 1897 he was office manager of the new Blake works at East Cambridge, Mass., also head of the estimating and cost department, later returning to the engineering sales department. The above companies were consolidated with others in 1901 to form the International Steam Pump Company, and Mr. Foran then went to New York, as manager and chief engineer of the condenser department of Henry R. Worthington and the associated companies of the International Steam Pump Company. He continued in that position with the Worthington Pump & Machinery Corporation which succeeded the International Steam Pump Company. Mr. Foran was active in the design of high vacuum apparatus during the entire development of that class of machinery and was at the head of the department at the time of his death. During the war, Mr. Foran served upon the committee for condensing apparatus of the United States shipping board and war industries board and as chairman of the American Engineering Service of the Engineering Council, which dealt with all questions of personnel between the various departments of the United States Government and the four national engineering societies.

TRADE PUBLICATIONS

Oxy-Acetylene Apparatus.—A brief outline of gas welding and cutting, together with descriptions and illustrations of acetylene generators, welding and cutting torches, pressure regulators, portable outfits and welding supplies are given in a circular of 16 pages recently issued by the Davis-Bournonville Company, Jersey City, N. J.

Viscosimeter Conversion Charts.—The May 1921 issue of Lubrication, published by the Texas Company, contains a chart for converting viscosimeter readings from one standard to another. By means of the diagram, the time or degrees can be read directly for the Saybolt, Engler, Redwood Admiralty, Saybolt Furol, or Barbey instruments.

Welding and Cutting Apparatus.—"Alternarc" is the title of a 52-page booklet issued by the Electric Arch Cutting & Welding Company, Newark, N. J. The book opens with a description of this company's standard welding machine and takes up in subsequent chapters welding in the shipbuilding field, steel mills, foundries, machine shops, etc. It also briefly explains the operation of the welding transformer and the advantages of the alternating current arc. Illustrations of welding repair jobs are included.

Electric Hoists.—A 12-page booklet has been issued recently by the Electric Hoist Manufacturers' Association, New York, and contains a somewhat lengthy list of successful applications of electric hoists in various industries. No attempt is made to discuss the details of hoist construction or to explain the method and convenience of operation, but numerous illustrations and references are given to show the labor saving effected by electric hoists in conjunction with monorail hoists, gantry and gib cranes.

Railroad Equipment.—An attractive booklet of 36 pages, Catalogue 145, has been issued by the Whiting Foundry Equipment Company, Harvey, Ill., in an effort to place before railroad men the advantages and labor-saving features of various Whiting railroad specialties, including locomotive hoists, coach hoists, cranes, transfer tables, turntable tractors, etc. The booklet also contains a general description and photographs of the company's products, together with numerous illustrations of the apparatus in actual operation. Two typical shop layouts are included.

Armco Iron.—"Armco in Picture and Fact" is the title of a well-arranged treatise issued by the American Rolling Mill Company, Middletown, Ohio. After a brief historical sketch of Armco iron, each step in its manufacture from the mining of the ore to the turning out of the finished material, is taken up in an interesting and comprehensive manner. The chemical purity, rust-resistance, welding properties and electrical conductivity of the iron are explained and many other features concerning Armco products. Reference, computing and export tables, and other useful data complete the book.

Water Softeners.—The Graver Corporation, East Chicago, Ind., has issued two bulletins describing the company's large continuous water softener (type K) and the small continuous water softener (type KM). Each bulletin opens with a short discussion of water softening and the choice of suitable apparatus. This is followed by descriptions of the operation of the plants which are described in detail and illustrated in numerous photographs. Drawings are shown of typical foundations and upper and lower housings and charts are given to illustrate the loss of water storage space by converting existing storage tanks into water softeners.

Oil Driven Air Compressors.—The oil engine driven air compressors manufactured by the Chicago Pneumatic Tool Company, New York, are described and illustrated in bulletin 607, recently issued. The booklet opens with a short general description of the machine and the type of fuel required. This is followed by a condensed illustrated description of the important details of construction. One of the interesting features of the bulletin is a comparison of the cost of operating an oil engine compressor unit and the comparative cost of operating an equivalent sized steam driven compressor. The concluding pages are devoted to illustrations of the various types of machines with tables of sizes, weights, etc.

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CONTENTS

EDITORIAL:
A Good Piece of Committee Work 477
Chemical Limits Specified for Iron Car Wheels 477
Locomotive Cut-Off Control 478
The Throttle vs. the Reverse Gear 478
Does Abrasive Adhere to Ground Surfaces? 478
Prepare Now for Future Machine Tool Needs 479
The Modern Driving Wheel Lathe 479
Getting Back to Normal 479
New Books 480

GENERAL:
Heavy Locomotives for the Southern Pacific 481
Maintenance of Air Operated Auxiliaries 484
Pulverized Lignite as Locomotive Fuel 487
The Automatic Control of Locomotive Cutoff 488
American Society for Testing Materials 493
Automatic Variable Exhaust Nozzle 494

CAR DEPARTMENT:
Factors To Be Considered in Freight Car Designing 495
Draft Gear Tests of the Railroad Administration 497
Scheduling and Routing Systems for Car Shops 502
Some Failures of Chilled-Iron Car Wheels 505
Standardizing Car Equipment 506

SHOP PRACTICE:
Relative Economy of Electric, Oil, Gas and Coal-Fired Furnaces 507
A Surgical Operation Performed on a Locomotive Valve Port 508
Reclamation Work on the Virginian 509
Device for Removing Air Compressor Pistons 510
Manufacturing Standard Locomotive Repair Parts 511
Reducing Maintenance Cost of Valve Chamber Bushings and Packing 513
A System for Numbering Shop Machinery 514
A Few Points on Grinding 514
Electric Power and Light for Railroad Shops 515
Truck for Driving Boxes 518
An Improved Chipping Screen 518
Locomotive Main Rod Angularity 519
Increasing the Efficiency of Piston Rod and Throttle Packing 520

NEW DEVICES:
Heavy Pattern 90-In. Driving Wheel Lathe 521
Buckeye Six-Wheel Freight Car Truck 522
Universal Type Suspension Journal Jack 524
Pneumatic Crude Oil Flange Lubricator 525
Vertical Bulldozer for Steel Car Work 526
Clutch Tap and Die Holder of Simple Design 526
Gasoline-Driven Portable Air Compressor 527
Air Operated Hoist of Novel Design 527
Driving Mechanism for Roundhouse Crane 528
Making Screws Hold in Any Material 529
Internal Grinder for Irregular Parts 529
Floating Holder Corrects Spindle Misalinement 530

GENERAL NEWS:
Notes 531
Meetings and Conventions 532
Personal Mention 533
Supply Trade Notes 533

A Good Piece of Committee Work

In its final report, an abstract of which appears elsewhere in this issue, the Committee on Air Consumption of Locomotive Auxiliary Devices of the Air Brake Association has completed an exceptionally good piece of work. The investigation was undertaken largely because the constantly increasing draft on the locomotive air compressor to supply these devices threatened the integrity of the air brake system, and it had for its main purpose the development of measures for the protection of the air supply for the operation of the brakes. In the course of its investigation the committee found the immediate difficulty to lie in the excessive air consumption of these devices, single units frequently exceeding the capacity of the pumps while in operation, and found the remedy to lie in the establishment of and adherence to a higher standard of maintenance. Too frequently, similar committees consider their work completed at this point, relying on general recommendations to effect the desired improvement in conditions. But this committee went further. Not only did it recommend a definite minimum standard of performance as a condemning limit and develop a simple and practicable method for its application, but it made a study of the economics of the maintenance of these devices, the result of which can leave little doubt in the mind of any mechanical department officer as to the dollars and cents value of the net return to be obtained from the additional expenditure required to keep them up to the recommended standards. The value of the report lies not so much in the manner in which the technical problems involved in the subject have been handled as in the sound business principles by which the committee has been guided in its investigations and in the formulation of its reports. The committee has wisely placed less stress on the primary object of its work than on the more tangible, though no more important, value of a higher standard of maintenance in saving the cost of producing unnecessary compressed air, and it has thereby developed a selling argument by the use of which the probability of attaining its main object has been very greatly increased.

Chemical Limits Specified for Iron Car Wheels

The importance of the standard specifications adopted by the American Society for Testing Materials is evidenced by the fact that they are widely recognized, universally respected and extensively followed. The reason for this lies in the fact that users, manufacturers and disinterested engineers and metallurgists are not only members of the society and serve on its committees, but also attend the annual meetings in force and take an active part in the discussions and determinations of these specifications. This was very clearly shown by the results of the 1921 meeting.

The most important action taken at this convention was the adoption of a tentative specification for chilled cast-iron car wheels and the inclusion in these specifications of chemical requirements as well as physical tests. The original draft of the specifications, as submitted by the committee, did not include chemical limitations, but as a result of a long discussion and in response to insistent demands on the part of car wheel manufacturers as well as railroad representatives, an analysis was agreed upon which will have a far-reaching effect on the whole car wheel industry. The improved service which undoubtedly will follow from the adherence of manufacturers to the chemical requirements laid down in this specification will be of the greatest value to the railroads of this country, who have been loath to abandon chilled cast-iron wheels despite the steadily increasing severity of the requirements imposed by changing operating conditions and increasing wheel loads.

Locomotive Cut-Off Control

The article on the "Automatic Control of Locomotive Cut-Off" published elsewhere in this issue, opens a wide field for discussion regarding economical locomotive operation. Probably no one will deny there are opportunities for improvement through scientific control of cutoff, but it is questionable whether the most desirable results would be obtained by making the cutoff dependent on the back pressure, at least in the present state of development of this method. The regulation of cutoff to produce a fixed back pressure is based on the theory that under certain conditions, shortening the cutoff produces an increase in the drawbar pull. However, experimental data shows that this is true only over a limited range and holds good only with comparatively long cutoff. Furthermore, the decrease in drawbar pull at longer cutoffs is primarily, if not entirely, due to a decrease in the steam pressure in the boiler, and it is an open question whether the decrease in the pressure does not furnish the best indication as to the advisability of shortening the cutoff.

The Throttle vs. the Reverse Gear

It is an interesting coincidence that at the time when automatic means of controlling cutoff are being considered in this country, a British technical periodical should discuss the time-worn subject of notching up vs. throttling. Representatives of the London publication, The Engineer, have recently completed a series of observations of locomotive handling on a number of important British railways. Our British contemporary compliments the skill of the enginemen and goes on to say: "When one observes the amount of driving that is done with the throttle instead of the reverse gear, and when one considers the little real knowledge of the superheater, it is difficult not to feel that effort is necessary to educate drivers in the handling of their engines better than hitherto." It was found that some drivers notched the engines up to some point varying from 30 to 50 per cent cutoff and regulated the power output by throttling. One engineman gave as the reason for not using an early cutoff the fact that the short valve stroke wore the valve spindle unequally. The Engineer points out that part of the advantage of superheating may be lost by such operation and states in conclusion: "It will be seen that we are under the impression that there is room for improvement in the manner that locomotives are often operated. Any improvement made by the better use of the expansive properties of steam will bring its certain return in decreased operating costs. This result can be obtained without incurring any expenditure. It is an economy secured by making better use of the locomotive as it is, without the addition of further devices. Modernizing steam locomotives calls for intelligent use being made of the devices fitted. Let us see that enginemen are helped to handle their locomotives efficiently. They must be taught the value of a wide open throttle, and of the expansive properties of high-pressure steam, and to assist them in the proper handling of the superheater must be given a pyrometer, which is as necessary to the working of the superheater as is the pressure gage to the boiler. We have heard it said that given a good pyrometer a steam gage is unnecessary. That may or may not be so. Certain it is, however, that given proper temperature readings, the steam pressure is practically sure to be right, but, on the other hand, satisfactory boiler pressure shown on the steam gage is by no means a guarantee that the temperature of the steam delivered to the engines is satisfactory."

Does Abrasive Adhere to Ground Surfaces?

The statement is occasionally heard among railroad men who ought to know better that small particles of abrasive from grinding wheels adhere to ground metallic surfaces. This statement has been absolutely refuted both by practical experience and by the most scientific physical tests. It is an understood fact that the success of many automobile manufacturers has been due to their ability to machine gasoline motor parts accurately and quickly on grinding machines. Many of these parts have ground bearings and their long life, when properly lubricated and adjusted for wear, affords ample proof that abrasive does not adhere to ground surfaces in such a way as to cause undue wear.

But it is not necessary to go to the automotive field for an illustration of the possibility and even economic necessity of grinding bearing surfaces. Many of the largest railroads in the country grind piston rods, valve stems, guides, crank pins, new driving axles, and in some cases car journals. No harmful results have followed the grinding of these parts and in fact the general tendency is to increase the life of the part. It is readily apparent that with a grinding machine properly adjusted and operated, the accuracy of a ground cylindrical surface exceeds the accuracy of a turned and rolled surface. The time required for the operation is less and, owing to the greater accuracy, the journal will have a longer life.

Not only has experience demonstrated the value of grinding for all sorts of bearing surfaces, but, as previously indicated, scientific experiments have failed to show any objections to this practice. Recently, samples of the surfaces of certain ground cylinders were submitted to the research laboratory of a prominent grinding machine company for examination. The findings of the investigators cannot be better expressed than by quoting the laboratory report: "The first examination of the sample submitted was made by using the highest magnification possible with a binocular microscope. This examination did not show the presence of any vitreous grain inserted in the metal. Frequently small pits were found but these contained no abrasive and are undoubtedly small blow holes in the metal.

"One-half of the sample was then dissolved in a one to one hot hydrochloric, plus five per cent sulphuric acid mixture. It was then filtered and washed with hot dilute hydrochloric acid, after which the residue was dried and examined microscopically for the presence of silicon carbide. No trace of this product could be found.

"The other half of the sample was polished on a small felt wheel coated with crocus in order to remove the finer scratches. The surface was then examined in reflected light with a metallographic microscope. No particles resembling abrasive were found. A portion of this polished surface was then etched with a five per cent nitric acid solution and again examined. Nothing was found which would indicate abrasive particles.

"We are therefore led to the conclusion that at least as far as the sample submitted is concerned there was no abrasive embedded in the surface of the metal."

Not only does every evidence point to the fact that abrasive is not embedded in ground surfaces, but these surfaces are smoother than can be obtained by any other method. Comparative microphotographs of ground and the most carefully reamed cylinders show that the latter are comparatively rough. In view of these investigations, it is evident that the prejudice against the use of grinding machines in railroad shops due to the supposed embedding of abrasive particles in ground surfaces, is unwarranted and railroad shop men should not allow this argument to deter them from using their influence wherever possible for furthering the installation of grinding machines, thereby effecting important economies by reduced maintenance and operating costs.

Prepare Now for Future Machine Tool Needs

Questions in connection with labor rates have commanded the attention of railroad motive power officers for some time and while rates have been reduced, it is not probable that they will again reach those prevailing before the war. In railroad work, as well as in manufacturing, the labor rate is not the only factor and frequently is not the largest factor in determining the cost of doing a certain piece of work. Other vital elements are the efficiency of labor and the facilities provided for doing the work. The big thing that should appeal to everyone in authority is the final cost of the job and not the labor rate. It is the duty of those responsible to see that the labor which they direct is used efficiently. Avoidance of waste in the use of labor in the shop requires the furnishing of adequate modern machinery properly equipped with tools and fixtures. During this period of business depression, master mechanics and shop foremen should take the occasion, as so many manufacturers are doing, to look into their entire shop equipment thoroughly and systematically in order to determine where the lack of proper tools will hold back production when the demand comes again—as come it surely will—and where the continued use of old machinery will add unnecessarily to the cost of turning out work over what it would be if modern machine tools were substituted.

There comes a time when economy demands that equipment be consigned to the scrap pile. Many machine tools that were used with fairly satisfactory results under labor conditions which prevailed a few years ago, can no longer be continued efficiently in service under present labor rates. When a weak spot is found, investigate what could be done with improved equipment, what type of machine is most suitable, the cost of the machine and its probable capacity for the work in mind. Even though no appropriation may be available at present or for some time to come, the man who knows what is needed, what the cost will be and what would be the probable results accomplished, is in a position to present facts which will enable him to obtain what he needs when the right time comes.

The Modern Driving Wheel Lathe

Many specialized machine tools have been developed for railroad shops and of these tools probably none has reached a more nearly perfected state than the driving wheel lathe. At least that is the impression gained by comparing recent models with wheel lathes made twenty or more years ago. There can be nothing but admiration for the powerful, high-production, conveniently operated machines, now used for turning locomotive driving wheel tires. True, the modern wheel lathe is an expensive machine, costing in the neighborhood of $20,000, and therefore not suitable for use in shops where only a small volume of work must be handled. The machine must be kept in operation a considerable proportion of the time, otherwise interest on the investment and depreciation charges will overbalance labor savings and economies resulting from modern improvements. Within reasonable limits, wheel lathe work should be concentrated at one point where a high production machine can be operated in two or more shifts, thereby proportionately increasing its possible savings.

As with all other questions, however, there is more than one side to this one. The modern wheel lathe is practically three machines in one and, when not used for turning tires, can be employed turning journals, facing hub plates, or quartering wheel centers. The fact that all of these operations can be performed on the same machine greatly extends the field of usefulness of that machine and enables it to be economically installed in far smaller shops than would otherwise be the case.

Modern wheel lathes are designed to stand all the severe usage encountered in turning the largest driving wheel tires and they force high speed lathe tools to the limit when cutting through tire treads hardened by slipping. Driving wheel lathes, made within the past few years, will turn a pair of the largest tires every hour on the average, including the time of setting up. By the use of high speed roughing tools, all excess material on a worn tire tread can be removed at one cut, whether it be ¼ in. or ¾ in. thick. The use of forming tools with ready means for changing from one tool to the other also enables accurate flange and tread contours to be machined quickly and with a minimum of physical effort..

Solid high speed lathe tools have been successfully eliminated in many modern railroad shops by substituting toolholders with high speed tool bits. Perhaps the main advantage of the latter practice is that so much money does not have to be tied up in solid high speed steel tools. The next advantage, and one which should not be overlooked, is the greater ease in grinding. A lathe operator will think twice before taking a pair of heavy solid lathe tools to the grinder and the tendency is to put off grinding as long as possible. With easily removable, high speed steel tool bits, however, there is every inducement to take them to the grinder frequently for touching up the top surfaces, because this requires no particular physical effort and greatly improves the cutting qualities of the tool, and consequently the production of the machine.

It is the duty of railroad mechanical officers to realize the possibilities of modern wheel lathes and make sure that antiquated, inefficient machines are not being used at points where the volume of work will pay handsome returns on the first cost of a new, high-power machine.

Getting Back to Normal

Ever since the slump in traffic occurred last fall, the railroads have been making a desperate struggle to bring their expenses back to a reasonable basis as compared with their earnings. There has been some slight improvement in recent months, but the definite turn for the better was expected to occur on July 1, when the new wage scale went into effect. Reports of earnings and expenses are slow in coming in and it will be impossible to tell for some time just what effect the reduction of wage rates will have on the net earnings. However, it is evident that the roads are looking for a better showing as maintenance work, which has been so severely curtailed, is now being resumed and efforts are being made to get the equipment in better condition.

Perhaps the most important factor in the railroad situation at the present time is the condition of freight cars. With 15.9 per cent in bad order on July 15, it is essential that repairs should be speeded up to put the equipment in condition to carry traffic, as the steady increase from week to week indicates that there will soon be business offered which the railroads will be unable to handle if cars are not in serviceable condition. Every mechanical department officer is interested in seeing a reduction in the number of bad-order cars. The railroads would like to get their rolling stocks back in normal condition, but the extent to which repairs can be carried on depends on the revenue that is available. Very large amounts will be needed to repair the heavy bad-order cars that are now setting on side tracks. In the first six months of this year, the heavy bad-order cars increased 139,193. It has been estimated that the average cost of repairs for these cars would be $1,100 and at this rate it would require $153,000,000 to make up the deficiency in freight car repairs that accumulated in the six months. This is almost one-fourth as much as was spent for maintaining freight cars during the entire year 1920. Even if this extra charge was spread out over a year, it would be difficult for the railroads to meet it. It is evident that getting the percentage of bad-order cars back to normal will be a long, hard process and little progress will be made unless the job is tackled promptly and vigorously. Some roads are apparently deferring action until they can see definitely the results of operation during July. It is encouraging to note that others have put on full forces in the shops and are showing their confidence in the future by making contracts for repairing a large number of cars.

NEW BOOKS

The Engineering Index, 1920. 586 pages, 7 in. by 9½ in. Published by The American Society of Mechanical Engineers, 29 West Thirty-ninth street, New York.

The Engineering Index which was published from 1892 to 1917, inclusive, by the Engineering Magazine Company and since then by the American Society of Mechanical Engineers, has for many years been recognized as the standard reference index to current engineering literature, and is practically indispensable to those who have frequent occasion to look up articles which have been written on subjects in this field. The completeness of the index is shown by the fact that the volume for the year 1920 covers nearly 14,000 articles from some 700 engineering and technical publications, together with society proceedings. Most of these are in English, but the more important articles in French, German and other languages are included also. The subject matter is arranged in alphabetical order with convenient main and sub-heads and gives a concise description of the substance of each article. The railway field is well covered and includes references to articles on management, operation, construction, maintenance, electrification, signalling, terminals, stations, freight handling, yards, track, maintenance of way, shops, locomotives and cars.

Fuel Economy on Locomotives. 51 pages; 3¾ by 5¾, cloth backed paper binding. Published by the American Railway Association, V. R. Hawthorne, Secretary, Mechanical Division, 431 South Dearborn street, Chicago.

The need for a manual of firing practice and of instructions in the principles of fuel economy for locomotive enginemen and firemen has long been recognized. Early in its history the International Railway Fuel Association gave considerable attention to this subject and at the 1912 and 1914 conventions laid the foundation for such a manual which it was proposed later to develop more fully. The first actual results, however, other than the development of such manuals by a few individual railroads, was accomplished by the adoption of the report of the Committee on Fuel Economy of the American Railway Master Mechanics' Association as recommended practice following the 1915 convention of that organization. This manual has stood as the recommended practice of the Master Mechanics' Association and its successor, the Mechanical Division of the American Railway Association, until the revision which was made and adopted by the Mechanical Division in 1920, to be followed by the further revision effected by the Joint Committee on Fuel Conservation of the Operating, Mechanical, and Purchases and Stores divisions this year. The principal revisions are the elimination of the text references to and the illustrations of cross firing and the addition of material concerning the proper firing of anthracite coal and fuel oil, the bringing up to date of the special instructions for the operation of superheater locomotives and the addition of about 15 pages of general information largely dealing with locomotive conditions affecting fuel economy, a small part of which is of more interest to roundhouse forces than to the engine crews and might, therefore, not improperly be omitted from a discussion of the subject intended primarily for distribution among enginemen and firemen. The book is well bound for pocket use, is well illustrated with colored plates showing various firebox conditions affecting proper combustion, and altogether is a material improvement over its predecessor. It is furnished by the association to members in lots of 100 copies or more for $20 per hundred, in lots of 50 copies for $12.50 and in less than lots of 50 copies at 30 cents each. Single copies are 60 cents each to non-members. The book will be of particular interest to those roads that have not already developed manuals of their own and any railroad that desires special printing on the cover or title page or wishes to incorporate these rules in a more extensive book in which are included special rules to meet local conditions, may arrange for such special printing.

Engineering Instruments and Meters. By Edgar A. Griffiths. 360 pages illustrated, 7 in. by 10 in. Bound in cloth. Published by D. Van Nostrand Company, New York.

Engineers in the course of their work usually become familiar with the commoner measuring instruments, but very few men have a thorough knowledge of all the types used even for the measurement of a single quantity. Problems involving careful measurement occur frequently in the shop as well as in the laboratory, and a knowledge of the basic principles of various measuring instruments, their field and their limitations is therefore a valuable asset. The author has treated briefly a great number of instruments, in many cases giving a simple exposition of the theory on which they are based. The object has been to enable the reader to choose the instruments best suited for various requirements.

Many of the types of apparatus described are generally regarded as applicable only to work in the scientific laboratory, but as pointed out in the preface, these are introduced because of novel features which will probably be incorporated in appliances used for industrial purposes. The chapters treat of the measurement of length, screw threads, area, volume, velocity force and mass, work, and temperature. Of particular value from the practical standpoint are the sections devoted to the measurement of screw threads and to pyrometers. The wide scope of the book makes it especially valuable to those engaged in testing work.

Handbook of Standard Details. By Charles H. Hughes. Leather, 312 pages, 4¾ in. by 7¼ in. Published by D. Appleton & Co., New York.

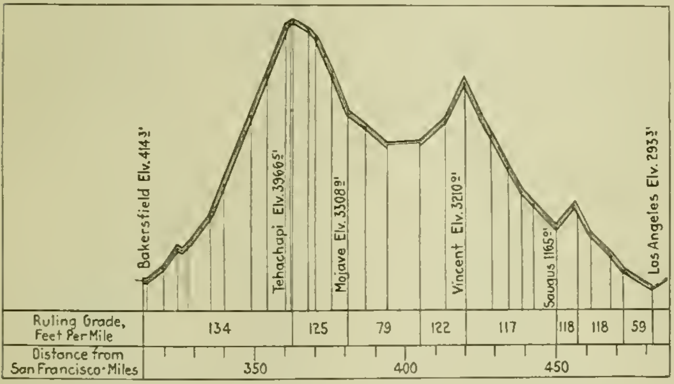
Although many handbooks are available and have proved to be of material assistance to engineers and designing draftsmen, this new work will undoubtedly be found a valuable addition for those engaged in the design of machinery or mechanical apparatus. The book, which is somewhat different in its scope from any other handbook, consists of a compilation of standard types of details of materials and manufactured parts used in machinery and engineering construction, together with drawings and tables giving dimensions, sizes, weights and other information gathered from American manufacturers of machine tools and other devices. The book is divided into convenient sections covering such subjects as the preparation of drawings, with such geometrical constructions as are commonly found necessary; fastenings, such as bolts, nuts, screws, nails, keys, gibs, pins and cotters; power transmission, including shafting and accessories, chain drives, belting and rope transmission; pipe, tubing and fittings, including iron, brass and copper; rope and chain fittings; miscellaneous details of machine tool and engine parts; structural details, including shapes, plates, beam connections and riveted joints, together with a section of miscellaneous tables of measures, weights and equivalents most commonly needed.

Waiting to Take a Train Over the Mountains

Heavy Locomotives for the Southern Pacific

Pacific Type Handles 11 Passenger Cars on 1.5 Per Cent Grade—New 2-10-2 Type Increases Tonnage

During the early part of the year, the Southern Pacific received from the Baldwin Locomotive Works 15 locomotives each of the 4-6-2 and 2-10-2 types. The 4-6-2 type was built particularly for use on heavy passenger trains between Ogden, Utah, and Carlin, Nev.; and the 2-10-2 type on heavy freight trains between Los Angeles, Calif., and Bakersfield.



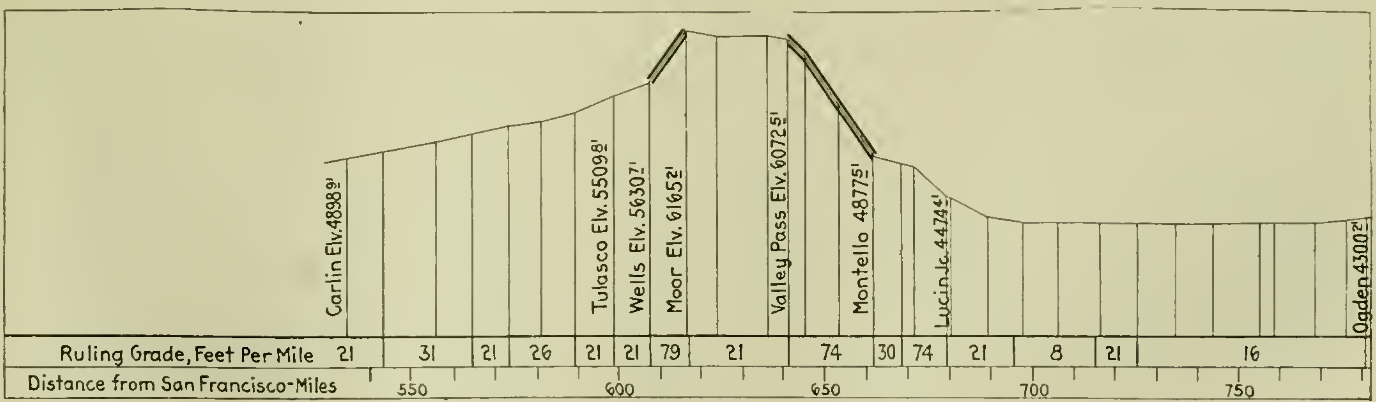
Profile of Road Between Bakersfield, Calif., and Los Angeles

Between Ogden and Carlin, a distance of 247 miles, the maximum grade is 1.5 per cent, 10 miles of which is encountered going east, and 20 miles going west, the remaining grades varying from 0.15 per cent to 0.6 per cent. These 4-6-2 type locomotives are capable of handling on this district, without helper service, a passenger train consisting of 11 cars, including Pullman cars, which weighs 875 tons. Locomotives of the lighter design of the 4-6-2 type, which the new locomotives displace, require helpers when going west from Montello to Valley Pass and from Wells to Moor going east.

Between Los Angeles and Bakersfield, a distance of 171 miles, there are 64 miles over grades of from 2.2 per cent to 2.37 per cent going west, and 73 miles over grades of from 2.23 per cent to 2.54 per cent going east, the remaining grades varying from 1.0 per cent to 1.5 per cent. The tonnage hauled by these 2-10-2 type locomotives is 1,005 tons going west, and 865 tons going east, or about 13 per cent over that handled by the former lighter 2-10-2 type locomotives.

The specifications and general designs for these locomotives were worked up under the supervision of George McCormick, general superintendent of motive power, and F. E. Russell, assistant mechanical engineer, the designs being completed and details worked out by the builders.

The 4-6-2 type locomotives have a rated tractive effort of 43,660 lb. with 180,000 lb. on drivers, the ratio of adhesion being 4.12. The total equivalent heating surface is 4,605 sq. ft. or 1 sq. ft. for each 9.5 lb. of tractive effort, this ratio

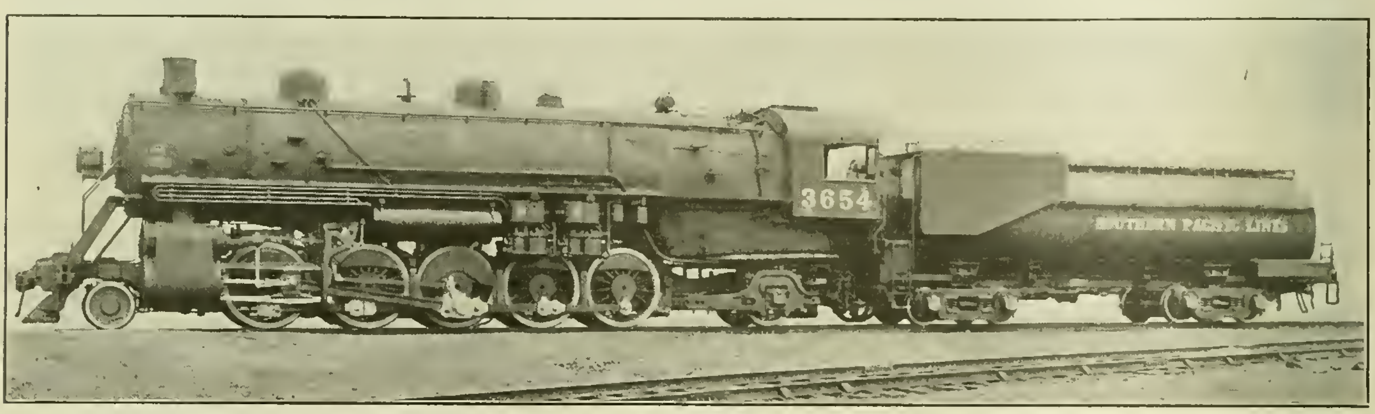


Profile of Road Between Carlin, Nev., and Ogden, Utah indicating good steaming capacity. The boiler is of the extended wagontop type with a wide firebox placed back of the drivers and over the rear trucks. A combustion chamber 3 ft. long extends forward into the boiler barrel, and the tubes have a length of 18 ft. The superheater consists of 40 units and has a superheating surface of 836 sq. ft. The cylinders have a stroke of 30 in., which is a departure from the usual practice in passenger locomotive design. The long stroke was based on the results of numerous tests of locomotives with superheaters made by the Southern Pacific, which justified the use of the longer stroke with superheated steam. The performance of these 4-6-2 type locomotives since going into service has proved that no mistake was made in adopting a longer stroke for passenger locomotives.

The 2-10-2 type locomotives have a rated tractive effort of 75,150 lb., with 297,300 lb. on drivers, the ratio of adhesion being 3.96. The total equivalent heating surface is 6,933 sq. ft., or 1 sq. ft. for each 10.8 lb. of tractive effort, this ratio likewise indicating excellent steaming capacity. The boiler is of the straight top type with a firebox 90 in. wide placed over the rear truck. The combustion chamber is 5 ft. 4 in. long, and the tubes have a length of 21 ft. The cylinders have a stroke of 32 in. and lateral motion driving boxes are provided on the first pair of drivers.

Among the specialties applied to both types of these locomotives are Commonwealth cast steel tender frames, four-wheel equalizing swing motion tender trucks, Delta type trailing truck frames, radial buffers, Unit type safety bars, Ragonnet power reverse gears, extended main driving boxes and Nathan non-lifting injectors. A complete installation of F.B.C. flexible staybolts is made in the breaking zone of the firebox and in the combustion chamber around the belly of the boiler.

Both types are oil burners and are equipped with Walschaert valve gear with the link block in the bottom of the link in forward motion, the gear being so arranged as to give equal cut-off at 55 per cent of the stroke. The lead is ¼ in., lap 1¼ in., exhaust clearance ⅛ in., and valve travel for


2-10-2 Type Locomotive for Handling 1,000 Tons on 2.4 Per Cent Grades

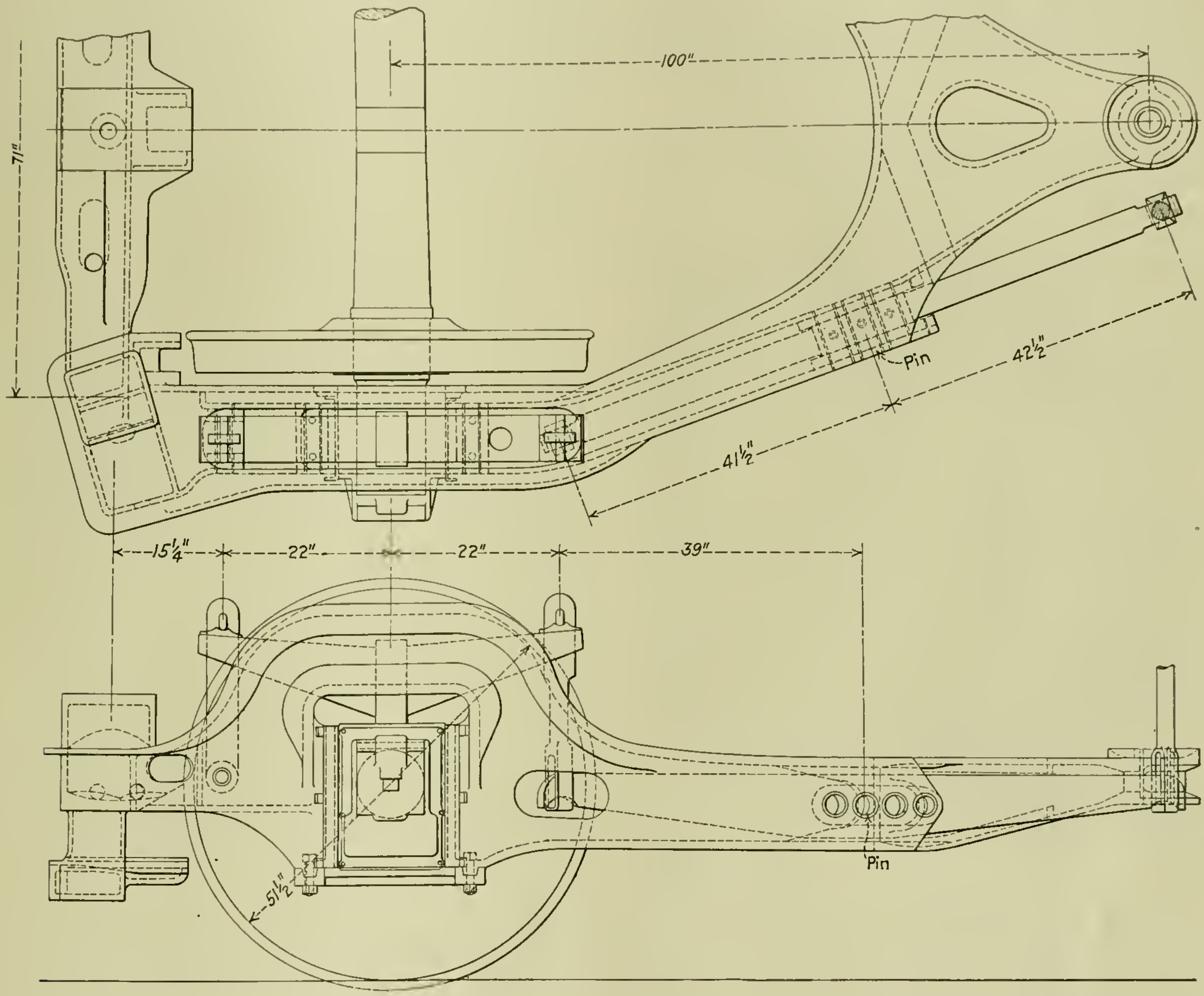
COMPARISON OF NEW AND OLD DESIGNS OF 4-6-2 AND 2-10-2 LOCOMOTIVES

	4-6-2 Type locomotives		2-10-2 Type locomotives	
Date built	1912	1921	1917-19	1921
Tractive effort	29,920 lb.	43,660 lb.	65,300 lb.	75,150 lb.
Cylinders	22 in. by 28 in.	25 in. by 30 in.	27½ in. by 32 in.	29½ in. by 32 in.
Weights:				
Total engine	220,900 lb.	297,800 lb.	348,000 lb.	385,900 lb.
On driving wheels	141,400 lb.	180,000 lb.	273,000 lb.	297,300 lb.
On leading truck	38,000 lb.	59,700 lb.	29,000 lb.	29,800 lb.
On trailing truck	41,500 lb.	58,100 lb.	46,000 lb.	58,800 lb.
Engine and tender	359,000 lb.	519,800 lb.	521,460 lb.	607,900 lb.
Wheel base, driving	13 ft. 4 in.	13 ft.	22 ft. 6 in.	22 ft. 10 in.
Wheel base, total	33 ft. 4 in.	35 ft. 6 in.	41 ft 6 in.	42 ft. 4 in.
Wheel base, engine and tender	63 ft. ¼ in.	75 ft. 9½ in.	80 ft. 2½ in.	82 ft. 7½ in.
Ratios:				
Weight on drivers, tractive effort	4.72	4.12	4.18	3.96
Equivalent heating surface*—Grate area	72.3	65.4	93.8	84.1
Per cent firebox heating surface to evaporative surface	6.34	8.41	7.34	7.79
Per cent superheating surface to evaporative surface	20.25	24.95	21.8	23.6
Total evaporative surface—Volume of cylinders	222.8	196.7	202.5	202.4
Wheels:				
Driving, diameter over tires	77½ in.	73½ in.	63½ in.	63½ in.
Driving, thickness of tires	3¾ in.	3¾ in.	3¾ in.	3¾ in.
Driving journals, main	10 in. by 12 in.	12 in. by 22 in.	12 in. by 22 in.	13 in. by 22 in.
Driving journals, front	9 in. by 12 in.	11 in. by 13 in.	10 in. by 20 in.	11 in. by 20 in.
Driving journals, others	9 in. by 12 in.	11 in. by 13 in.	10 in. by 13 in.	11 in. by 13 in.
Engine truck wheels, diameter	33 in.	36 in.	33 in.	33 in.
Engine truck journals	6 in. by 10 in.	7 in. by 12 in.	6 in. by 12 in.	6 in. by 12 in.
Trailing truck wheels, diameter	45½ in.	51½ in.	45½ in.	45½ in.
Trailing truck journals	8 in. by 14 in.	9 in. by 14 in.	8 in. by 14 in.	9 in. by 14 in.
Boiler:				
Style	Straight Top	Ext. Wagontop	Ext. Wagontop	Straight Top
Working pressure	200 lb.	200 lb.	200 lb.	200 lb.
Outside, diameter, first ring	70 in.	78 in.	82 7/16 in.	90 in.
Firebox, length and width	108 in. by 66 in.	120¾ in. by 84 in.	120⅛ in. by 75¼ in.	132 in. by 90 in.
Tubes	182—2 in.	193—2¼ in.	279—2 in.	261—2¼ in.
Flues	24—5⅜ in.	40—5½ in.	40—5⅜ in.	50—5½ in.
Tubes and flues, length	20 ft.	18 ft.	20 ft. 6 in.	21 ft.
Heating surface, tubes and flues	2,571 sq. ft.	3,069 sq. ft.	4,130 sq. ft.	4,722 sq. ft.
Heating surface, firebox	175 sq. ft.	282 sq. ft.	327 sq. ft.	399 sq. ft.
Evaporating heating surface, total	2,745 sq. ft.	3,351 sq. ft.	4,457 sq. ft.	5,121 sq. ft.
Superheating surface	556 sq. ft.	836 sq. ft.	972 sq. ft.	1,208 sq. ft.
Equivalent heating surface,* total	3,579 sq. ft.	4,605 sq. ft.	5,915 sq. ft.	6,933 sq. ft.
Grate area	49.5 sq. ft.	70.4 sq. ft.	63 sq. ft.	82.5 sq. ft.
Tender:				
Tank	Cylindrical	Cylindrical	Cylindrical	Cylindrical
Water capacity	7,000 gal.	12,000 gal.	10,030 gal.	12,000 gal.
Oil capacity	2,940 gal.	4,000 gal.	3,120 gal.	4,000 gal.

*Equivalent heating surface equals total evaporating heating surface plus 1.5 times the superheating surface.

the 4-6-2 type 6½ in. and for the 2-10-2 type, 7 in. These valve events were decided upon from experiments made during the locomotive tests above referred to, proving to be the most efficient of the numerous combinations tried.

The counterbalance is designed to balance only 50 per cent of reciprocating parts and to produce a dynamic augment at diameter speed not exceeding 50 per cent of the static wheel load. The reciprocating parts are very light, the piston heads being of the built-up type with cast iron bull-rings, and the piston rods of open-hearth steel, heat-treated, and hollow bored. The main and side rods are also of very light design, all being of I-section except the side rods on the 2-10-2 type locomotives, which are rectangular. All driving axles and main and forward crank pins are made of open-hearth heat-treated steel, and are also hollow bored. Constant resistance leading trucks are applied to both types of locomotives.



Trailing Truck With Equalizer Between Trailing and Driving Wheels

The trailing trucks on the two types of locomotives are interchangeable and are equalized with the drivers by means of equalizing beams which are fulcrumed on the truck frame. With this arrangement, which is a new departure for this type of truck, the load is transferred to the truck frame at the radius bar pin and through two sliding bearings placed on the right and left sides back of the truck wheels.

In both the 4-6-2 and the 2-10-2 locomotives, the weight on the trailing trucks is approximately 58,000 lb. The weight at the radius bar pin of the trucks is about 45,000 lb. and on each of the pads back of the wheels, 20,500 lb. The load at the equalizer fulcrum pin is a little over 28,000 lb. and between 14,000 lb. and 15,000 lb. on each hanger. In previous designs of the Delta truck, the weight was not equalized between the trailing wheels and the driving wheels.

The tenders, which are of the Vanderbilt type, are unusually large, having a capacity of 12,000 gal. of water and 4,000 gal. of oil. The tender trucks are of the equalized type with journals 6½ in. by 12 in.

The accompanying tabulation shows the principal dimensions, weights and ratios of the two new types, and, for comparison, of lighter locomotives of the same types which were superseded by the new power between the points mentioned.

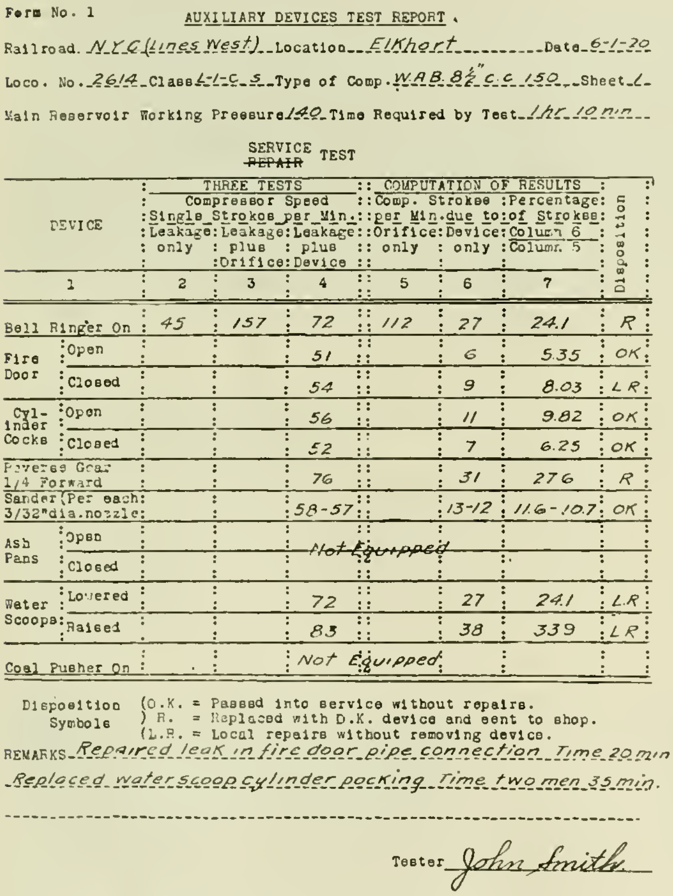
Diesel Locomotives for Industrial Service.—Benz & Company of Mannheim, Germany, has brought out a line of Diesel locomotives especially designed for industrial purposes. The locomotives work without compressors and hence are really semi-Diesels, the fuel being delivered by the feed pump direct into the cylinders. The engine is started by means of the slightly compressed air stored in a cylinder during the working of the engine; the cylinder is sufficiently large to admit of restarting several times on one charge. The locomotives are built in sizes up to 200 hp. and are arranged for three speeds.

Maintenance of Air Operated Auxiliaries*

A Big Net Saving Effected by the Application of Air Brake Association Condemning Limits

THE report of the committee submitted last year† was intended to be final, but the report was received with so much discussion that the committee was continued with a view to attaining the following objects:

1. To obtain more complete and representative data concerning the air consumption of locomotive auxiliary devices.
2. To follow up, with the assistance of the Air Brake Association members, the use of the test code and determine its weak points with a view to suggestions for revision of its method or the limits imposed.
3. To devise a convenient system for recording and reporting a maintenance program both from the standpoint of the cost and the value of benefits derived.
4. To obtain reliable and accurate data of the cost factors involved in a maintenance program for air operated locomotive auxiliary devices.
5. To simplify the practical application of the test code to the work of testing auxiliary devices on steam locomotives.
6. To investigate the condition of air operated auxiliary devices on electric locomotives.
7. To devise a method of test and formulate a test code which will be adequate to determine the condition of air operated auxiliary devices on electric locomotives.
8. To determine test limits which can be used to condemn electric locomotive auxiliary devices out of service for repair or replacement.



Form No. 1

AUXILIARY DEVICES TEST REPORT

Railroad. N.Y.C (Lines West) Location Elkhart Date 6-1-20

Loco. No. 2614 Class L-1-C-S Type of Comp. W.A.B. 8½" C.C 150 Sheet 1

Main Reservoir Working Pressure 140 Time Required by Test 1 hr 10 min

SERVICE ~~REPAIR~~ TEST

DEVICE		THREE TESTS			COMPUTATION OF RESULTS			Disposition
		Compressor Speed Single Strokes per Min.			Comp. Strokes per Min. due to		Percentage of Strokes	
		Leakage only	Leakage plus Orifice	Leakage plus Device	Orifice only	Device only	Column 6 / Column 5	
1		2	3	4	5	6	7	
Bell Ringer On		45	157	72	112	27	24.1	R
Fire Door	Open			51		6	5.35	OK
	Closed			54		9	8.03	L R
Cylinder Cocks	Open			56		11	9.82	OK
	Closed			52		7	6.25	OK
Reverse Gear 1/4 Forward				76		31	27 6	R
Sander (Per each 3/32"dia. nozzle				58-57		13-12	11.6-10.7	OK
Ash Pans	Open			~~Not Equipped~~				
	Closed							
Water Scoops	Lowered			72		27	24.1	L.R
	Raised			83		38	339	L R
Coal Pusher On				Not Equipped				

Disposition Symbols
(O.K. = Passed into service without repairs.
) R. = Replaced with O.K. device and sent to shop.
(L.R. = Local repairs without removing device.

REMARKS Repaired leak in fire door pipe connection Time 20 min
Replaced water scoop cylinder packing Time two men 35 min.

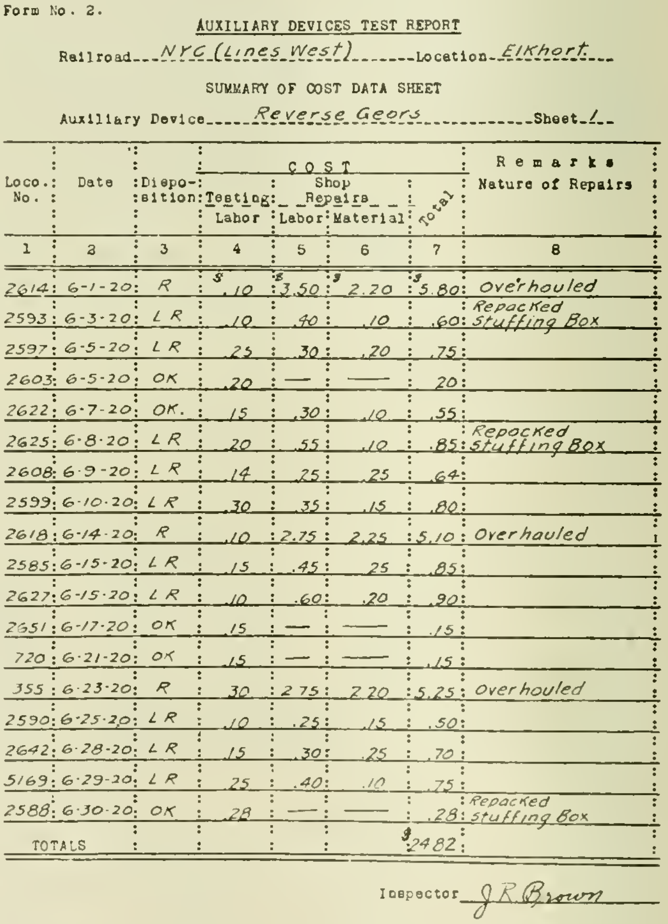
Tester John Smith

Fig. 1—Form No. 1, Auxiliary Devices Test Report on Which Record of Test Results Is Made

The committee prepared a small pamphlet to cover the code for testing air operated auxiliary devices on steam locomotives. This pamphlet was published by the Air Brake Association, and contained an illustrated plan for making auxiliary device test reports so as to cover not only actual test results, but all the cost factors of maintenance as well. This plan was worked out so that complete reports could be made with the use of only three different forms.

The object of preparing the pamphlet was to get this information in convenient form to send out, with requests that maintenance programs be initiated and the results reported to the committee as outlined. It was recognized that if reliable maintenance cost figures were to be secured it would be necessary to obtain them from several localities, and the work would have to be done in systematic and uniform manner, so that the data would be comparable and the averages truly indicative of general conditions.

The committee realized that these requests represented a very large amount of work and expenditure, but it was their judgment that in every instance where the request was complied with the actual benefits derived would more than offset expenses and effort expended on it.



Form No. 2.

AUXILIARY DEVICES TEST REPORT

Railroad NYC (Lines West) Location Elkhart

SUMMARY OF COST DATA SHEET

Auxiliary Device Reverse Gears Sheet 1

Loco. No.	Date	Disposition	COST				Remarks
			Testing	Shop Repairs		Total	Nature of Repairs
			Labor	Labor	Material		
1	2	3	4	5	6	7	8
2614	6-1-20	R	$ .10	$ 3.50	$ 2.20	$ 5.80	Overhauled
2593	6-3-20	L R	.10	.40	.10	.60	Repacked Stuffing Box
2597	6-5-20	L R	.25	.30	.20	.75	
2603	6-5-20	OK	.20	—	—	20	
2622	6-7-20	OK.	.15	.30	.10	.55	
2625	6-8-20	L R	.20	.55	.10	.85	Repacked Stuffing Box
2608	6-9-20	L R	.14	.25	.25	.64	
2599	6-10-20	L R	.30	.35	.15	.80	
2618	6-14-20	R	.10	2.75	2.25	5.10	Overhauled
2585	6-15-20	L R	.15	.45	25	.85	
2627	6-15-20	L R	.10	.60	.20	.90	
2651	6-17-20	OK	.15	—	—	.15	
720	6-21-20	OK	.15	—	—	.15	
355	6-23-20	R	30	2 75	2 20	5.25	Overhauled
2590	6-25-20	L R	.10	.25	.15	.50	
2642	6-28-20	L R	.15	.30	.25	.70	
5169	6-29-20	L R	.25	.40	.10	.75	
2588	6-30-20	OK	.28	—	—	.28	Repacked Stuffing Box
TOTALS						$ 2482	

Inspector J R Brown

Fig. 2—Form No. 2, Summary Record of Tests of Each Device on Which Cost of Testing and Repairs Is Entered

Auxiliary Devices Test Report

The three forms were prepared with the object of simplifying the work of recording the data required. They were designated as Forms No. 1, No. 2 and No. 3.

Form No. 1 is intended for the use of the workman or tester in recording the data of the tests as made on the engine and to record the disposition of the devices as determined by the result of the test data computations. All tests were classi-

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*Abstract of a report presented at the open meeting of the Executive Committee of the Air Brake Association, held at the Hotel Sherman, Chicago, May 3, 1921.

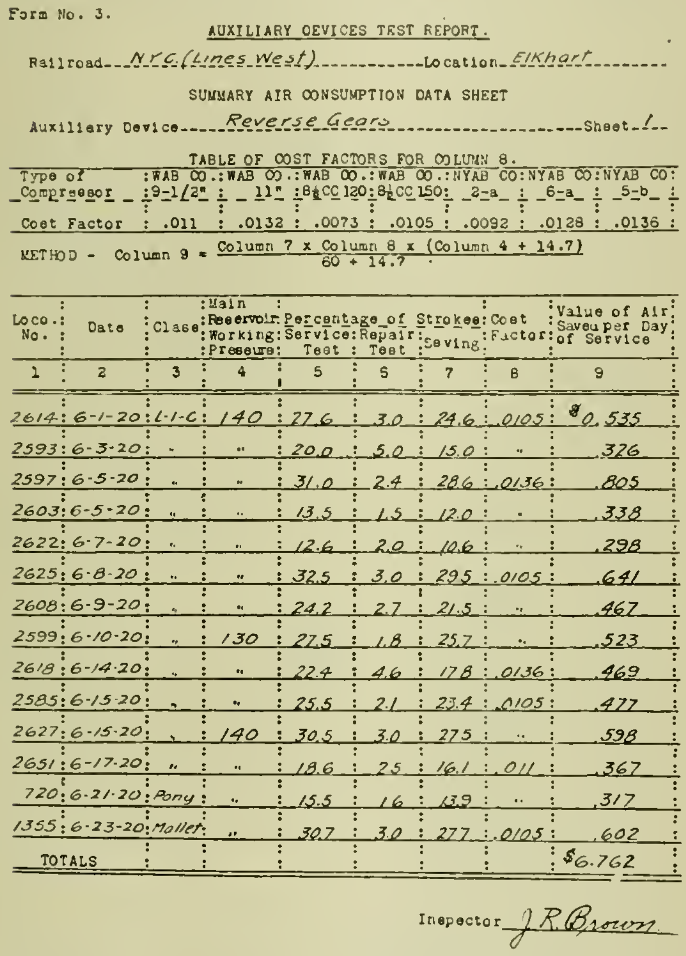
†See the *Railway Mechanical Engineer* for June, 1920, page 395.

fied as either "Service" or "Repair" and were to be reported on separate sheets with the kind of test indicated as described. When repairs or replacements were made as a result of service tests, repair tests to check the condition of devices going into service were to be made and reported.

It is recommended that service tests of auxiliary devices be made at regular intervals with the time of service between tests not more than three months.

Form No. 2 was intended for making a monthly summary of the maintenance cost for each kind of auxiliary device maintained. The data for this sheet are obtained from the test sheets submitted by the tester and the repair shop cost department.

The disposition symbols given at the bottom of Form No. 1 indicate the disposition of tested devices in each case. When the device is found O. K., the only cost is that required to cover the labor of testing. When the device is condemned but is made good by local repairs without removing the device from the locomotive, the cost includes the testing labor and in addition whatever labor was required to make the repairs plus cost of any material used. When the device is condemned and replaced by a new or repaired device, the cost includes the testing labor plus the average cost for overhauling the particular kind of device in the shop and the cost of the labor necessary to make the replacement.



Form No. 3.

AUXILIARY OEVICES TEST REPORT.

Railroad N.Y.C.(Lines West) Location Elkhart

SUMMARY AIR CONSUMPTION DATA SHEET

Auxiliary Device Reverse Gears Sheet 1

TABLE OF COST FACTORS FOR COLUMN 8.

Type of Compressor	WAB CO. 9-1/2"	WAB CO. 11"	WAB CO. 8½CC 120	WAB CO. 8½CC 150	NYAB CO 2-a	NYAB CO 6-a	NYAB CO 5-b
Cost Factor	.011	.0132	.0073	.0105	.0092	.0128	.0136

METHOD - Column 9 = $\frac{\text{Column 7 x Column 8 x (Column 4 + 14.7)}}{60 + 14.7}$

Loco. No.	Date	Class	Main Reservoir Working Pressure	Percentage of Strokes Service Test	Repair Test	Saving	Cost Factor	Value of Air Saved per Day of Service
1	2	3	4	5	6	7	8	9
2614	6-1-20	L-1-C	140	27.6	3.0	24.6	.0105	$0.535
2593	6-3-20	„	„	20.0	5.0	15.0	„	.326
2597	6-5-20	„	„	31.0	2.4	28.6	.0136	.805
2603	6-5-20	„	„	13.5	1.5	12.0	„	.338
2622	6-7-20	„	„	12.6	2.0	10.6	„	.298
2625	6-8-20	„	„	32.5	3.0	29.5	.0105	.641
2608	6-9-20	„	„	24.2	2.7	21.5	„	.467
2599	6-10-20	„	130	27.5	1.8	25.7	„	.523
2618	6-14-20	„	„	22.4	4.6	17.8	.0136	.469
2585	6-15-20	„	„	25.5	2.1	23.4	.0105	.477
2627	6-15-20	„	140	30.5	3.0	27.5	„	.598
2651	6-17-20	„	„	18.6	2.5	16.1	.011	.367
720	6-21-20	Pony	„	15.5	1.6	13.9	„	.317
1355	6-23-20	Mallet	„	30.7	3.0	27.7	.0105	.602
TOTALS								$6.762

Inspector J. R. Brown

Fig. 3—Form No. 3, Summary Record for Each Device on Which Value of Saving in Air Consumption Is Computed

Form No. 3 is similar to Form No. 2 in that it was intended to serve the supervising inspector for keeping a summary record of the amount saved as a result of the maintenance repairs provided for each kind of device. The computation of the value of compressed air saved was greatly simplified by the cost factors and method given in the heading of this sheet.

The cost factors to be used in Column 8 depend on the type of air compressor employed for the test in each case. They have been worked out on the basis of certain assumptions as follows. That the average working time of locomotives is six hours per day; that the boiler factor of evaporation is seven pounds of water per pound of coal; that the cost of coal on the tender is $2 per ton; that the compressor steam consumption in pounds per 100 cubic feet of free air compressed is 68 for Westinghouse 9½-in. and 11-in. compressors and New York 2-a compressor, 24 for the Westinghouse 8½-in. c.c. compressor, 56.3 for the New York 6-a compressor and 44.7 for the New York 5-b compressor.

The actual computation of the factors can best be illustrated by the following example in which the 9½-in compressor factor is derived:

6x60 = Total minutes per day of service.
7 = Factor of evaporation.
$2.00 = Price of coal per ton.
2,000 = Pounds per ton.
68 ÷ 100 = Steam consumption per cu. ft. of free air.
3 ÷ 9.5 = Cubic feet of free air per one per cent of compressor strokes saved.

Then—

$$\frac{6\times60\times68\times2.00\times3}{7\times100\times2000\times9.5} = .011$$

It has been pointed out that the above plan for computing the saving due to auxiliary device maintenance is based on the value of compressed air only. There are other factors, such as cost of water, wear on compressor plant, etc., but these have been omitted because to properly consider them would add more complication to the computations than is justified by the importance of these factors and because their omission is in the direction of placing the saving values on a more conservative basis.

Maintenance Cost Data

Complete reports, including cost factors, were received from three railroads, and one of these reports was analyzed to show how the information would apply to the system as a whole provided a maintenance program was carried out at all repair points. The summary and analysis follows.

On this railroad there are in service 878 bell ringers, 811 single unit and 67 double unit fire doors, or a total of 945, and 667 single unit and 209 double unit sanders, or a total of 1,087 of such devices. A summary of the results obtained by inspection and repairs is shown in Table I.

Table I—Summary of Test Reports on One Railroad

	Number tested	Average repair cost	Cost of air saved per device per six hours of service (coal at $2 per ton)	Corrected cost of air saved (coal $3.531 per ton)
Bell ringers.....	47	$1.18	$.0483	$.0768
Fire doors......	59	1.21	.0486	.0772
Cylinder cocks..	3	.76	.1000	.159
Sanders	51	.62	.153	.2435

It is estimated that the actual hours of service per day for each device are three hours for the bell ringers, six hours for the fire doors and one hour for the sanders. The number of engines in actual service on this railroad averages about 85 per cent of the total number of engines, so that the average number of auxiliary devices in service each day is 746 bell ringers, 852 fire doors and 915 sanders. On this basis the savings effected by testing and repairing the devices have been computed and are shown in Table II.

Table II—Saving Per Year Effected by Reducing Air Consumption of Auxiliary Devices to Within the Limits Prescribed in the Test Code

Device	Total saving by reduction of air consumption	Total cost of testing and repairs to devices	Net saving
Bell ringers...........	$10,450.00	$1,037.00	$9,413.00
Fire doors	24,007.00	1,142.00	22,865.00
Sanders	13,540.00	673.00	12,867.00
Totals	....	$2,852.00	$45,145.00

These results clearly show the immense possibilities for greater economy in a properly directed and executed plan for maintenance. It is reasonable to assume that the unit repair costs, which were determined by what it cost to repair a few long neglected devices, could be greatly reduced if the devices were handled in greater numbers and always given periodic attention.

The test code has been criticised because it is difficult for the tester to apply the condemning limits to the test results. The committee has devised a method whereby the condemning limits can be based on compressor strokes as shown in Table III. This table is greatly condensed and arranged so it can be printed or pasted on a card in a form convenient for the tester to carry with him. It is made up so as to cover all types of steam-driven air compressors, but in most cases the tester will only be required to deal with two or possibly three different types so that the size of the table can be very much reduced by omitting the data for the types of compressors not used. The limits as so defined are not absolutely accurate, but their application will yield results that will be quite satisfactory for the purpose intended. The use of this limit table need not conflict with the use of Forms No. 1, No. 2 and No. 3 for making auxiliary devices test reports.

TABLE III—AIR AUXILIARY DEVICES CONDEMNING LIMITS

Type of Pump*	W. A. B. Co., 9½ in.				W. A. B. Co., 11 in.			W. A. B. Co., 6½ in., 120			W. A. B. Co., 8½ in., 150			N. Y. A. B. Co., 2-a				N. Y. A. B. Co, 6-a				N.Y.A.B.Co., 5-b		
Pump strokes per minute due to orifice only	90	100	110	120	80	90	100	80	90	100	80	90	100	90	100	110	120	90	100	110	120	80	90	100
Bell ringers	9 to 11				6 to 8			4 to 5			3 to 4			10	12	13	14	6 to 8				4 to 5		
Fire door	14	16	17	19	11 to 13			7	8	9	5 to 6			18	19	21	23	10	11	12	14	7	8	9
Cylinder cocks, reverse gear and sander	28	32	35	38	21	24	27	14	16	17	9	10	12	34	38	42	46	21	23	25	27	14	16	17
Ash pan	43	47	52	57	32	36	40	20	23	25	14	16	18	52	57	63	68	31	34	37	41	20	23	25
Water scoop and coal pusher	57	63	69	70	42	48	53	27	31	34	19	21	24	69	76	84	92	41	45	50	54	27	31	34

*Device passes test if strokes made by pump due to device only are not more than values given.

Test Code Limits

During the past year's experience in the use of the test code, the committee gave considerable study to the leakage or air consumption limits prescribed by the code. These limits were presented to and adopted by the Association with the understanding that they were to be regarded as tentative and subject to revision. The committee is agreed that up to this time experience has shown that the limits of permissible rates of air consumption are much higher than can be justified from either the basis of repair costs or the basis of compressed air savings. This fact was very evident to most of the test code users, several of whom commented to that effect.

In the report submitted to this Association last year the code limits were defined and illustrated in terms of cubic feet of free air consumed per minute. It was thought that a better conception of the magnitude of the limits could be given if they were shown compared relatively on the basis of leakage area through the device.* It is the judgment of the committee that the code limits can and should be materially decreased.

Electric Locomotives

The most difficult feature in connection with the treatment of auxiliary devices on electric locomotives was the task of devising a suitable method for testing. The method and code devised for testing auxiliary devices on steam locomotives worked out in a very simple and convenient way because after adjustment of the apparatus the only observation necessary was the counting of the steam compressor strokes. The same plan could not be carried out for making auxiliary device tests on electric locomotives because of the totally different characteristics of the motor driven compressors and their method of control, but it was deemed desirable to follow the method of the steam locomotive tests as nearly as possible. It was decided to eliminate the compressor and base the observation on the time required for the auxiliary device to cause a given drop in main reservoir pressure. This method has the same advantages as the steam locomotive tests; namely, a minimum of test apparatus and only one observation, but it is somewhat more difficult to reduce the test observations to a form which will express the rate of air consumption in cubic feet of free air per minute. The test code has been given a trial in service and it has shown results which are both practical and dependable.

The committee does not deem itself qualified at this time to suggest a set of condemning limits for application to tests of auxiliary devices on electric locomotives. While the test code has been used sufficiently to fully demonstrate its practicability, our experience covers the testing of comparatively few locomotives and we do not have complete knowledge of the functions and importance of some of the auxiliary devices in question. The fixing of tentative and final condemning limits lies within the province of those members of the Association who are directly responsible for the operation of auxiliary devices on electric locomotives. They should have no difficulty in establishing limits after the code has been in use for a short time.

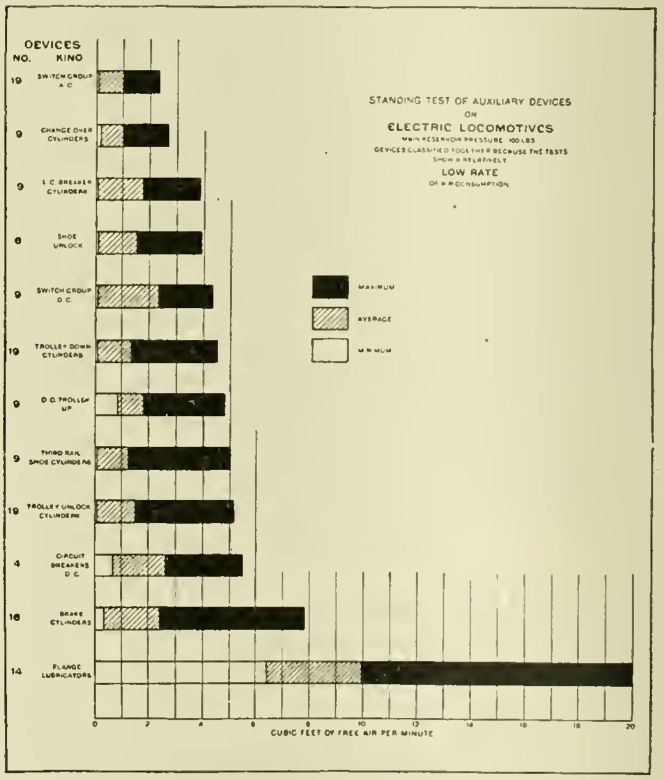


Fig. 4—Air Consumption of Electric Locomotive Auxiliary Devices Which Showed a Relatively Low Rate

The standing tests made on electric locomotive auxiliary devices included a total of 346 devices on 49 locomotives belonging to three different railroad systems. When the data from these tests were computed and tabulated, it was noticed that the various types of devices could be classified as low or

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*The report contained a chart comparing the orifice sizes equivalent to the leakage rates at the condensing limits, with an orifice ⅛ in. in diameter. The areas of these orifices have the following proportionate value of the area of the ⅛ in. orifice: bell ringers, 71 per cent; fire doors, 120 per cent; cylinder cocks, reverse gears and sanders, 237 per cent; ash pans, 357 per cent; water scoops and coal pushers, 476 per cent.

high depending on the rate of air consumption found. The data were, therefore, plotted according to this classification and are shown in Figs. 4 and 5, respectively.

General Discussion

It is essential whenever work is done to promote economy that an accurate record be kept or otherwise the work will be in danger of classification as unnecessary and will be cut off. The plan has been worked out so that with the use of only three forms it will be convenient to keep the record up to date and ready for making a complete report on short notice, or at stated intervals, such as monthly or quarterly. The executive officers of railroad systems who are responsible for the efficient operation of locomotives are often too busy to appreciate the value of auxiliary device maintenance unless they can have access to a record which will give them at a glance the summation of repair costs compared to the benefits derived.

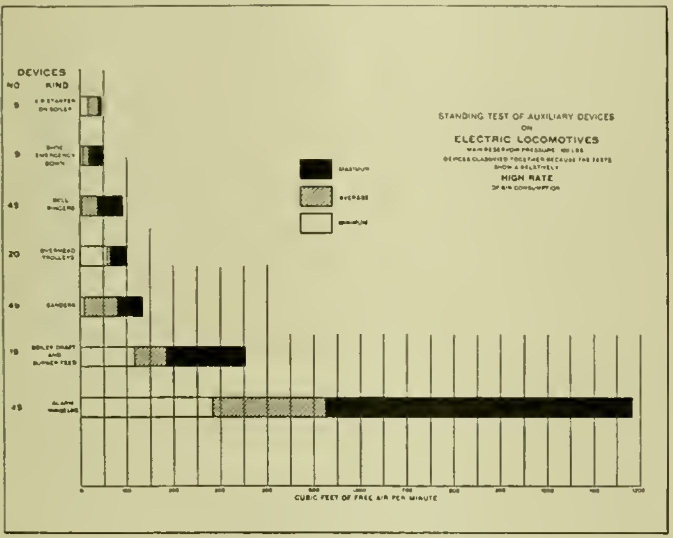


Fig. 5—Air Consumption of Electric Locomotive Auxiliary Devices Which Showed a Relatively High Rate

The maintenance programs which were reported according to the plan show results that would be hard to credit if it were not possible to check up the records by comparison. The tremendous margin for economy is more evident than it has been in any of the data submitted previously by this committee. The yearly saving of more than $45,000 for a railroad system that uses less than 1,000 locomotives is remarkable. Of course, this value is based on cost of testing and repairing all auxiliary devices at least once a year. It might be possible that the average need of repairs would prove to be more than once a year for each device. In such event, the savings figures would be reduced by the increased cost of repairs, but this reduction would not seriously affect the margin of saving. The figures show that the frequency of repairs could be increased to four times a year or once every three months for each device and still permit a saving of more than $36,000. It should be borne in mind that this saving does not take into account the large benefits derived in the way of more reliable and efficient auxiliary device operation. Locomotive failures and expensive delays are frequently chargeable to auxiliary devices when the latter are poorly maintained.

Standing tests show that the average condition of auxiliary devices on steam locomotives is far below the standard that should and can be maintained. Figures obtained from tests made this year are not much different from those presented in previous reports and they confirm all the original conclusions.

The electric locomotive auxiliary device tests indicate that many of these devices use much more air than should be required for the functions they perform. The consistently low minimum values of air consumption rate found on most types of devices show that their condition is about on a par with that of auxiliary devices on steam locomotives. It will be noted that very high rates of air consumption were observed for some of the devices; in fact, the larger of these values are much in excess of anything experienced in tests made on steam locomotives. The average rate for alarm whistles is more than 500 cu. ft. per minute, and the maximum on one whistle was as high as 1,180 cu. ft. per minute or about 25 times the nominal capacity of the C-60 compressor commonly used on electric locomotives. This rate is equivalent to an orifice ¾ in. in diameter and no doubt this whistle is like the one made famous by Mark Twain.

The report is signed by C. H. Weaver (New York Central), chairman; C. B. Miles, (Big Four), W. W. White (Michigan Central), and R. E. Miller, (Westinghouse Air Brake Company).

Pulverized Lignite as Locomotive Fuel

In a written discussion of the report of the Committee on Pulverized Fuel presented at the 1921 convention of the International Railway Fuel Association, W. D. Wood (Fuller Engineering Company) presented the following data relative to locomotive tests with pulverized North Dakota lignite.

An average analysis of this coal as mined, is as follows: moisture, 40.53 per cent; volatile, 27.05 per cent; fixed carbon, 27.37 per cent; ash, 5.05 per cent; B. t. u. value, 6,644.

After being in transit for about a month when received at Fullerton, this coal had a moisture content of approximately 33 per cent, which after unloading and being allowed to stand in the open for several days was further reduced to about 24 per cent. After being crushed, dried and pulverized, this coal showed a moisture content of 13.68 per cent, the volatile content being 41.02 per cent, fixed carbon 38.02 per cent, ash 7.28 per cent, and the B. t. u. value 9,303. As far as could be determined by the eye or touch, this prepared coal was as dry as eastern coals which contain but 1 per cent of moisture, showing that the moisture content of the lignite coal was mainly inherent moisture.

The actual evaporation per pound of dry coal varied from 5.6 to 5.74 lb., the equivalent evaporation per pound of dry coal varying from 6.75 to 6.92 lb.

Contrary to expectations, no difficulty of any kind was encountered due to the high moisture content of the coal and it burned at all times with a clear, bright flame and practically colorless stack. The amount of slag and ash remaining in the fire pan or combustion chamber was the least which had been encountered with any kind of coal which had so far been burned on this locomotive, including bituminous, anthracite silt, etc. The amount of honeycomb which was formed on the flue sheet was practically negligible and did not interfere with the steaming of the locomotive.

Little change was made in the equipment on the locomotive to burn the lignite from what was previously used to burn the mixture of anthracite silt and bituminous. The tips in the exhaust pipes were bored out 3¾ in. diameter each, whereas they had previously been 3½ in. in diameter for the hand fired locomotive and 4 in. when burning the mixture of anthracite and bituminous. The only other change was the placing of three more air openings in the bottom of the fire pan or combustion chamber.

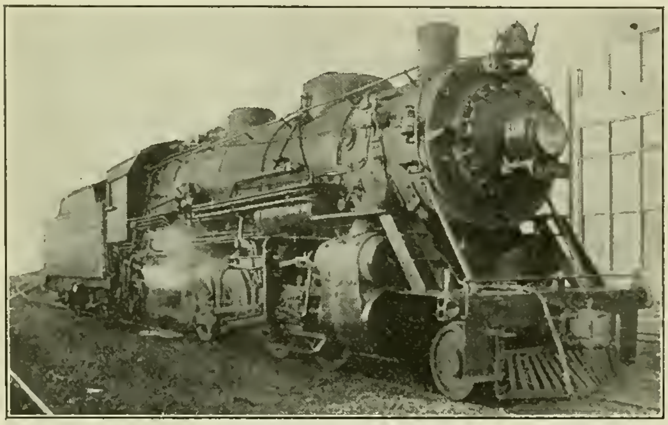
According to the statistics of the American Iron & Steel Institute, the tonnage of rails produced in the United States in 1920 was 2,604,116, an increase of 400,273 tons, when compared with 1919, a decrease of 340,045 tons as compared with 1917—the best war year—and a decrease of 898,664 tons as against 1913. Of the 1920 tonnage, only 142,899 tons were made by the Bessemer process.

The Automatic Control of Locomotive Cutoff

Tests on Big Four Demonstrate Its Practicability, Utilizing Back Pressure as Actuating Force

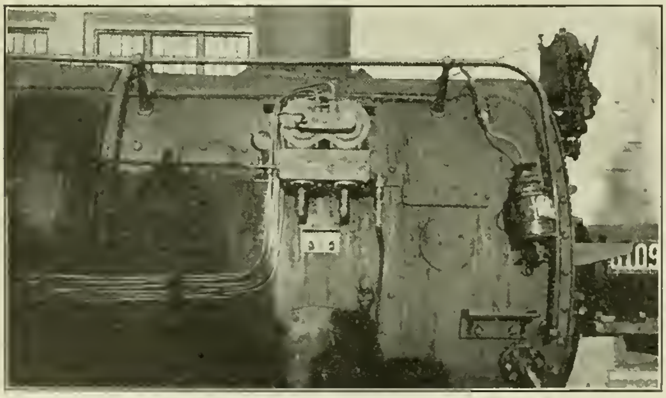
BY E. S. PEARCE
Mechanical Engineer, Cleveland, Cincinnati, Chicago & St. Louis

LOCOMOTIVE drawbar pull is the result of steam pressure on the pistons. Variations in the amount of draw bar pull with changes in speed re the result of variations in the average pressure against the pistons, and changes in the average pressure against the pistons are the result of changes in the quantity, pressure and temperature of the steam admitted to the cylinders at the beginning of the stroke.



Mikado Locomotive Equipped for Automatic Control of Cutoff

Graphically, the relation of quantity and pressure are represented by the indicator card. As shown by Fig. 1, steam is admitted to the cylinder from the point of admission *A* to the point of cutoff *B*, at a pressure of *P* lb. At the point *B* the amount of steam in the cylinder, for all practical purposes, is the amount used in the development of the work of one stroke. From *B* the steam expands the remainder of the stroke to the point of release *C*. On the return stroke the steam is expelled from the cylinder between *C* and *D* to the point of compression. During the time this steam is being expelled it is exerting against the piston a back pressure P_2 tending to reduce the positive force of the steam against the opposite face of the piston.



Differential Valves Connected to Exhaust Passages and to Reverse Gear

The exhaust or back pressure, P_2, varies directly with the admission pressure P_1, the length of cutoff, speed and the ability of the boiler to supply steam at the rate required to maintain P_1. It varies indirectly with the size of exhaust ports and passages.

Fig. 1 shows the value of back pressure when a constant cutoff is used through a range of increasing speeds as compared to the changes that take place in the admission pressure. The admission pressure falls off with increasing speed due principally to the inability of the boiler to supply steam in such increasing quantity and also on account of the decreased time interval for admission. Back pressure increases with increased speed due almost entirely to the shortened time interval for the escape of the steam. The net effect of the change in P_1 and P_2 was to reduce the area of the indicator card, which is the measure of the average mean effective cylinder pressure.

From the indications of the card, it is reasonable to suppose that somewhere between 12 and 26 miles an hour a shortening of the cutoff would have produced a card of greater area, regardless of the fact that a lesser number of cubic feet of steam would have been admitted to the cylinders. This increased area would be due to the higher value of P_1 caused by the smaller demand on the boiler and there being less steam in the cylinder to be exhausted the value of P_2 would be less. Should this supposition prove correct the decrease in drawbar pull would be less rapid and the amount of work per pound of steam used would be greater. Within the reasonable limits of practical application it is also possible that the exhaust pressure may bear a relation of a more or less constant nature to P_1, the point of cutoff and the speed, such that by adjusting the cutoff to hold the exhaust pressure at a constant value an indicator card of the maximum area will be obtained for each speed within the limits of the boiler capacity.

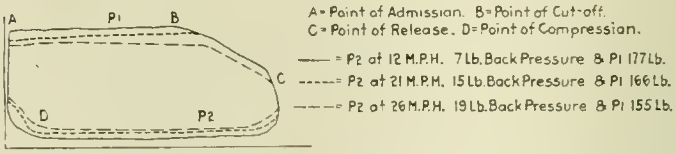


Fig. 1—Indicator Card Showing Relation Between Exhaust and Admission Pressure and Area with Fixed Cutoffs as Speed Increases

The theory so far advanced, if of any practical value, should easily be demonstrated by the analysis of actual road tests conducted for that purpose. Such tests have been conducted on the Big Four in which no refinements of observation or calculations were indulged in not within the reasonable limits of every day performance. The conclusions, therefore, are within the reasonable limits of practical application.

It is first necessary to determine just what relation cutoff bears to drawbar pull, then what relation mean effective cylinder pressure bears to cutoff, through the same range of speeds. These relations being established, the variation of exhaust pressure as related to speed, cutoff, or mean effective cylinder pressure can easily be determined. Since the exhaust creates draft and draft supports combustion, which must go on at a certain rate to supply steam, the relation of exhaust pressure and draft must also be determined. Part of the heat of combustion is used in superheating the steam. Since the steam supply, as controlled by cutoff, bears a possible relation to exhaust pressure and since draft may also bear such a relation, it is essential that the relation of superheat to back pressure be determined throughout the working range of cutoffs.

For determination of the above relations and variations in each specific element, a stoker fired locomotive of the Mikado type with the following dimensions was used:

Cylinders	27 in. by 30 in.
Tractive effort	50,000 lb.
Diameter of drivers	63 in.
Steam pressure	200 lb.
Grate area	60 sq. ft.
Evaporative surface	4,650 sq. ft.
Superheat surface	1,163 sq. ft.
Weight on drivers	246,000 lb.

Valve gear, Walschaert.

With respect to the relation of the position of the reverse lever to the amount of steam travel of the piston for several positions of the reverse lever, it should be noted that from the corner back to the third notch the cutoff was shortened .705 in., from the third to the sixth notch 2.135 in., and from the sixth to the ninth, the shortest cutoff, 5.74 in. The effect of one notch adjustment near the corner is, therefore, about one-eighth that of one notch near the center.

The range of speed through which one cutoff will maintain a greater drawbar pull than the next longer or shorter cutoff is very clearly shown in Fig. 2 by the relation of the drawbar pull-speed curves for the positions of cutoff with the reverse lever in the first, third, sixth and ninth notches. The extent to which the use of one cutoff through a considerable range of increasing speeds will tax boiler capacity is shown by the rate at which boiler pressure falls off as speed increases. It is evident that using the incorrect cutoff when maximum capacity is required will not only prevent such capacity being developed, but will needlessly tax the steaming capacity of the boiler. Cutoff changes to develop maximum drawbar pull at each speed on this particular class of engine should be made as follows:

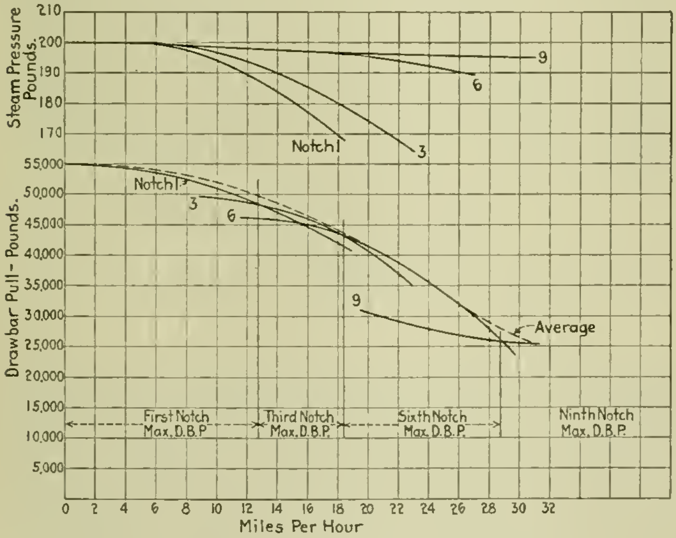


Fig. 2—Variation of Drawbar Pull and Boiler Pressure as Speed Increases with Four Positions of Cutoff

First notch, 89.1 per cent C. O.	0 up to 12-14 m.p.h.
Third notch, 86.75 per cent C. O.	12-14 m.p.h. to 18-19 m.p.h.
Sixth notch, 79.65 per cent C. O.	18-19 m.p.h. to 28-30 m.p.h.
Ninth notch, 60.5 per cent C. O.	28-30 m.p.h. up.

In actual practice with either increasing or decreasing speed this number of cutoff changes would not be made, although the advantage of so doing must be evident. In fact, the notches between those cited could be used with profit.

Mean effective cylinder pressure, back pressure and their relation to speed are shown in Fig. 3. Since mean effective cylinder pressure produces drawbar pull, the cutoff changes required to hold it at the maximum with changing speed should correspond to those required to hold drawbar pull at the maximum. From Fig. 3 these are found to be as follows:

First notch	Up to 12-14 m.p.h.
Third notch	12-14 m.p.h. to 15-16 m.p.h.
Sixth notch	15-16 m.p.h. to 28-30 m.p.h.
Ninth notch	28-30 m.p.h. and up.

The slight discrepancy in speed at the upper limit of the third notch and the lower limit of the sixth notch does not detract from the theory and the fact that mean effective pressure falls off at a more rapid rate than boiler pressure, as shown in Fig. 2, while back pressure increases in practically direct proportion to increasing speed, is a practical demonstration of the theory set forth in connection with Fig. 1. Attention is called to the fact that the back pressure curve for each cutoff shows a value of approximately 10 lb. at the same speed at which the cutoff should be changed to hold mean effective pressure as well as drawbar pull at a maximum.

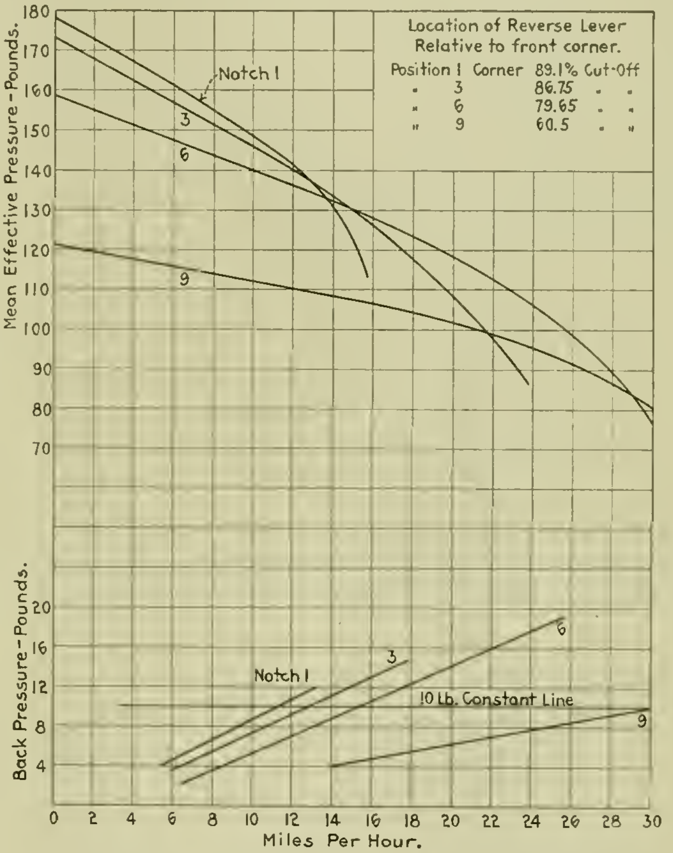


Fig. 3—Relation Between Average Mean Effective Pressure, Back Pressure and Speed for Four Positions of Cutoff

Since back pressure apparently bears some constant relation to mean effective cylinder pressure and thence, through cutoff, to drawbar pull, there must be some point of maximum return to be expressed in pounds mean effective cylinder pressure per pound of back pressure. Fig. 4 shows the ratio of mean effective pressure to pounds of back pressure for the various cutoffs and back pressures. The longest cutoff gives the maximum return in pounds mean effective pressure per pound of back pressure up to a point between 10 and 12 lb. back pressure, which occurs for this cutoff at 12 to 14 miles an hour. All values of cutoff show that with 10 to 12 lb back pressure the pounds mean effective pressure per pound of back pressure are approximately the same. Therefore, if each cutoff is changed when a speed is reached such that back pressure has reached between 10 and 12 lb., the maximum return for the back pressure carried will be obtained, both in economy as to mean effective pressure and capacity as to the drawbar pull obtained as a result of the change. That 10 to 12 lb. back pressure is the point of maximum return is still further evidenced by the fact that the relative positions of the several curves in Fig. 4 are reversed on either side of this critical range.

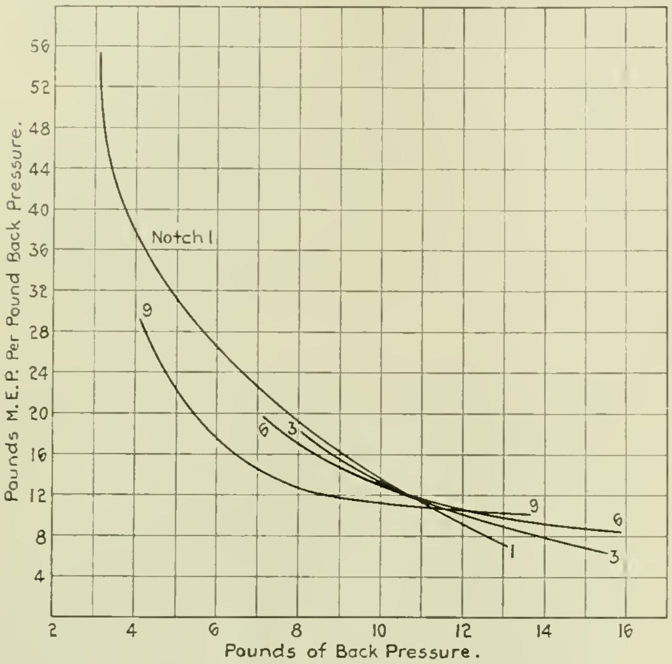


Fig. 4—Average Pounds Mean Effective Pressure Per Pound Back Pressure for Four Positions of Cutoff

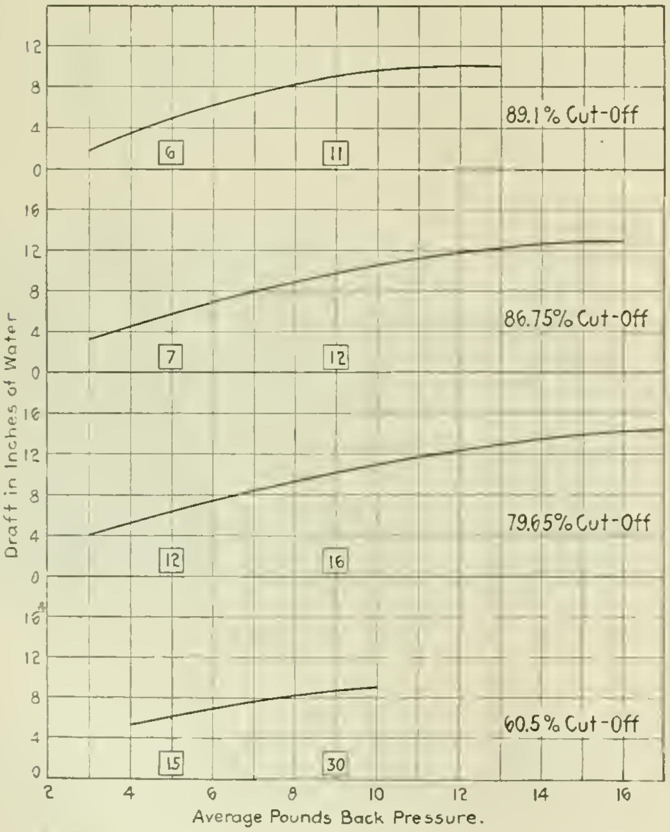


Fig. 5—Back Pressure and Average Draft at Base of Stack for Four Positions of Cutoff with Varying Speed

The relation of draft to back pressure is shown in Fig. 5. Dr. Goss in his book on "Locomotive Performance," states that:

"First—Changes in cutoff have no effect upon the form and character of the jet, except insofar as they affect the quantity of steam discharged.

"Second—With a given weight of steam discharged, whether in heavy exhausts incident to low speed, or the more rapid impulses at high speed, the draft resulting is practically the same. But whenever the weight of steam discharged per minute changes, the draft will change.

"Third—In any boiler the condition of draft determines the rate of combustion and consequently under ideal conditions, the draft will be a function of the rate of combustion."

From Fig. 5 it will be seen that for all of the cutoffs shown, constant back pressure is synonymous with constant draft. This seems to be contradictory to the first and second conclusions of Dr. Goss since as speed increases and cutoff is shortened, the quantity of steam exhausted per minute increases with speed as shown by Figs. 6 and 7. It should be noted that as cutoff is shortened with increased speed the amount of steam discharged per exhaust decreases from 2 miles an hour to 28 miles an hour by 45.8 per cent, whereas the quantity per minute increases over the same range by 1,460 per cent. At low speeds the intervals between exhausts is large and the quantity of steam discharged per exhaust is also large. At high speeds the intervals between exhausts is small and the quantity of steam discharged per exhaust is also small. Low frequency and high quantity in one case is equalled by high frequency and small quantity in the other; the result is a constant.

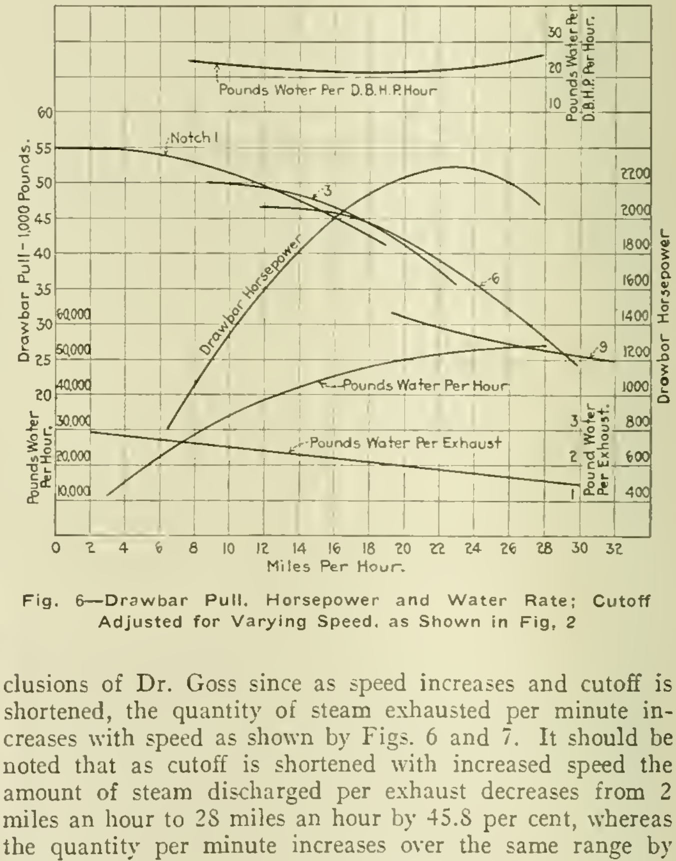


Fig. 6—Drawbar Pull. Horsepower and Water Rate; Cutoff Adjusted for Varying Speed. as Shown in Fig, 2

Constant draft through a range of speed requiring an increasing rate of steam supply and consequently an increasing rate of combustion if steam pressure is to be maintained within working limits, may seem to be contradictory to the third deduction made from the experiments of Dr. Goss. Analysis of the conditions of actual operation very easily explains the consistency of both statements. To supply steam at low rates a heavy fire is used, giving greater resistance to the passage of a given quantity of air through the fuel bed in a given time, hence a high draft is required although less air is required in a given time than at high speed. To supply steam at high rates a light fire is used with lower resistance to the passage of the air, yet the quantity of air required in a given time is greater than at low speed. For all practical purposes draft is constant for varying rates of combustion and the air supply automatically controlled by the thickness of the fuel bed.

The statement that conditions of operation actually require constant draft is further substantiated by the relation of superheat to back pressure. Shortening the cutoff to hold back pressure constant as speed increases results in constant draft and as a result of this regulation of the quantity of steam passing through the superheater, practically a constant amount of superheat is obtained throughout a great range of speed. For back pressures from 8 to 13 lb. the superheat is the same. The higher back pressure is the maximum of economical return in draft and the range is within that obtained with low as well as high speed.

In summing up the analysis of back pressure and the relation of back pressure to the several features of locomotive operation it would seem that operating an engine to constant back pressure should regulate the cutoff to sustain the maximum drawbar pull at all speeds and consequently develop the maximum drawbar horse power at each speed; and that in developing the maximum drawbar horse power at each speed the required number of pounds of water per drawbar horse power would be supplied, the draft and superheat being so regulated that the boiler would maintain adequate working pressure.

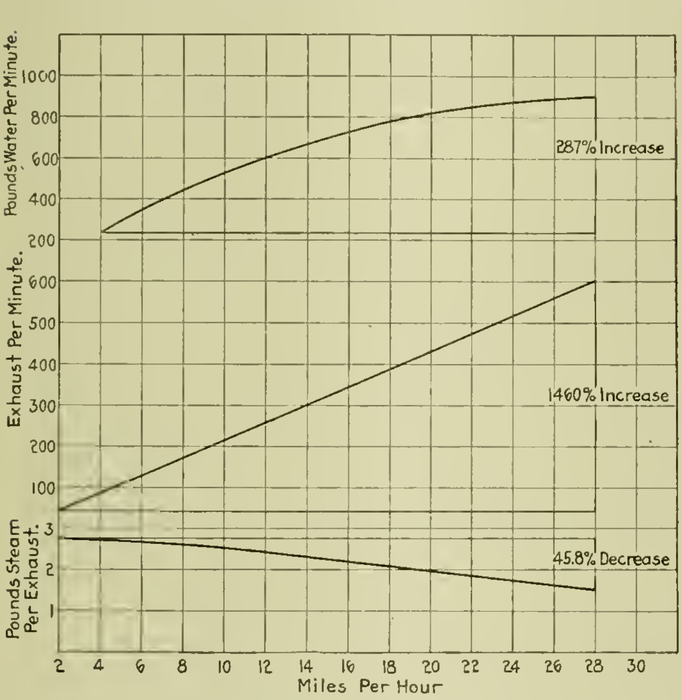


Fig. 7—Total Rate of Steam Discharge Per Minute. Cutoff Changed at Speeds as Shown on Fig. 2

With the pressure, volume, and temperature of the steam used in a given time known, it is possible to calculate the weight of steam used within practical limits of accuracy, which is sufficient for comparing the steam consumption per unit of work at one speed with that at another. From the indicator card the volume of the steam and the average pressure at the point of cutoff can be obtained. The temperature of the steam may be that shown by the pyrometer, which will give the degrees superheat over the saturated temperature at the cutoff pressure, or the total superheat over the saturated temperature at cutoff may be assumed as that of the saturated temperature at boiler pressure plus the degrees superheat indicated by the pyrometer. In either case the error is negligible. From the data shown on Fig. 6 and previous charts, such calculations may be made.

Applying this method of calculation, the amount of steam per minute, per exhaust and per drawbar horsepower-hour shown in Table I and in Figs. 6 and 7 have been obtained. The water or steam per drawbar horsepower hour is well within the limits of economical performance and at the maximum is within the limit of economical combustion.

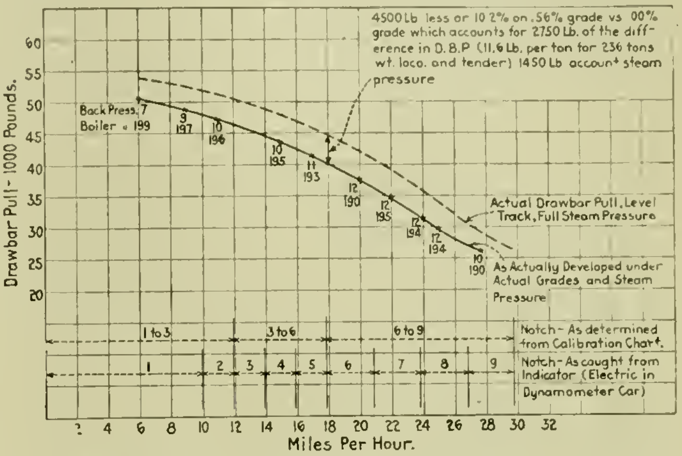


Fig. 8—Maximum Drawbar Pull Compared with That Developed by Regulating Cutoff to Maintain Constant Back Pressure

The ability of the engine to maintain steam pressure when operated at 10 to 12 lb. back pressure and the extent to which the maximum drawbar pull will be developed at each speed is shown in Fig. 8. In the operation of the reverse lever to hold the back pressure constant, accelerating a maximum tonnage train from 3 to 28 miles an hour on grades of —.13 per cent to +.629 per cent, the cutoff was changed 14 times in 7 min. 23 sec. and in a distance of 2.4 miles.

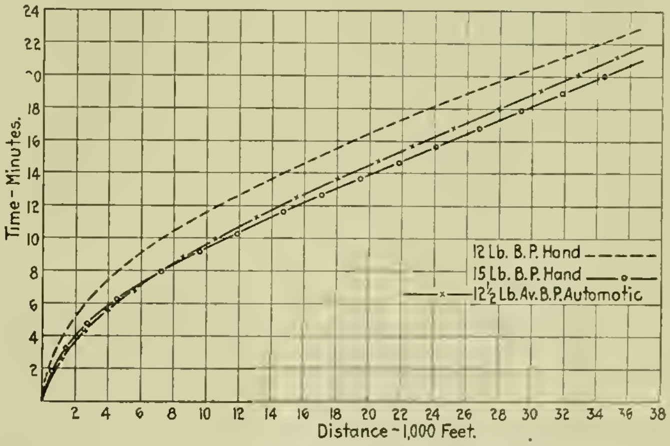


Fig. 9—Time Distance Curves for Runs Under Varying Conditions of Back Pressure

The practical application of the back pressure method of cutoff control so far as the manual operation of the reverse lever is concerned, presents a serious problem because too much of the engineman's time would be required to properly manipulate the reverse lever. To overcome the disadvantage of manual operation of the reverse lever the back pressure principle has been applied to a system of valves which, actuated by back pressure and synchronized with the throttle, automatically operates a power reverse gear to adjust the cutoff and thereby relieve the engineman.

Automatic operation of the reverse lever possesses mechanical, economical and capacity increasing advantages, and it is also on the side of safety. Mechanically the advantages are independence of valve setting, reach rod length or fineness of the quadrant notches, and the elimination of mechanical appliances for the indication of speed, making the adjustment independent of conditions of wear, which would tend toward the inaccuracy of a mechanical speed actuated device. Economical advantages are the operation of the unit to the maximum economical capacity as to hauling light trains or heavy trains at the speeds consistent with the loading, and uniform and synchronous operation with respect to steam generation and consumption, draft, cutoff, superheat, and drawbar pull. From the standpoint of safety, the advantages are—relief for the engineman from a time absorbing duty, permitting concentration upon such other operating duties as the water, sand, throttle and signals.

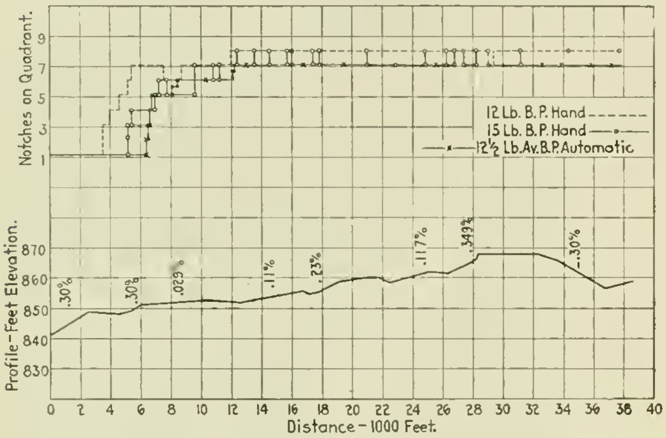


Fig. 10—Profile and Reverse Lever Positions for Runs Shown in Fig. 9

The automatic device for the adjustment of cutoff consists essentially of three parts. Two differential valves set one pound apart are provided, one for shortening the cutoff when the back pressure increases, and the other for lengthening the cutoff when the back pressure decreases. Both valves are connected to the four exhaust passages of the cylinder saddles and to the air supply for the power reverse gear. A circular quadrant and cutout valve are so arranged that a finer cutoff than the engine will practically operate under at high speeds cannot be obtained. The circular quadrant permits the reverse lever to follow the gear and indicates the cutoff and also serves as a quadrant for the reverse lever when under hand control. A control valve is connected to the throttle so that the engine is placed in automatic cutoff and the reverse lever cannot be manipulated by hand when a full throttle is used. At any predetermined speed the throttle may be manipulated to restore hand control and with a small throttle opening, such as used in the movement of the engine alone or the engine and a few cars, the reverse lever may be manually operated.

Table I—Comparison of Steam Consumption in Lb. per Minute as Calculated from Indicator Card by

(1)—Pressure and Temperature at Cutoff, Plus 250 Deg. Superheat, and

(2)—Pressure at Cutoff and Temperature at Boiler Pressure, Plus 250 Deg. Superheat

Miles per hour	Revolutions per minute	Volume of four cylinders per revolution at % cutoff	Cubic feet steam per minute	Cu. ft. steam per pound at cutoff pressure plus 250° superheat	Pounds steam per minute	Pounds steam per exhaust	Cu. ft. steam per lb. at cutoff pressure and temperature at boiler pr., plus 250° s.h.	Pounds steam per minute	Pounds steam per exhaust	Exhausts per minute
2	10.7	35.4	379	3.2	118.5	2,75	3.2	118	2.75	42.8
4	21.4	35.4	757	3.28	231	2.7	3.28	231	2.7	85.6
6	32.0	35.4	1130	3.34	338	2.66	3.4	332	2.59	128.0
8	42.7	35.4	1510	3.5	430	2.53	3.46	436	2.86	170.8
10	53.5	35.4	1890	3.6	525	2.45	3.6	525	2.45	214.0
12	64.0	35.4	2260	3.7	610	2.38	3.8	595	2.32	256.0
14	74.8	34.5	2580	3.89	663	2.21	4.0	645	2.16	299.0
16	85.5	34.5	2950	4.05	728	2.13	4.1	720	2.1	342.0
18	96.2	34.5	3320	4.2	790	2.06	4.3	772	2.01	384.0
20	107.0	31.6	3380	4.4	767	1.79	4.5	780	1.75	428.0
22	117.5	31.6	3710	4.6	807	1.72	4.7	790	1.68	470.0
24	128.5	31.6	4070	4.8	849	1.65	4.9	830	1.615	514.0
26	138.0	31.6	4360	5.0	872	1.58	5.2	840	1.53	552.0
28	156.0	31.6	4920	5.5	895	1.49	5.7	865	1.44	600.0

Note—Cutoffs and speeds as shown in Fig. 2.

Three comparative tests to determine the advantages of automatic operation were conducted under constant conditions of train loading, grade and direction. In the first test, the reverse lever was operated by hand to hold 12 lb. back pressure and the time to cover a given distance, while accelerating the train from a stand, was recorded. The second test was the same except that 15 lb. back pressure was to be maintained. The conditions of the third test were the same except that the reverse lever was automatically operated to maintain 12½ lb. back pressure. All tests started from the same point and a full throttle was required. The train consisted of 55 loaded cars of 3,479 tons actual weight.

Fig. 9 is the time-distance chart of these runs, which shows that six miles was covered in 20.9 min. in the first test, in 18.5 min. in the second test and in 19.3 min. in the third test.

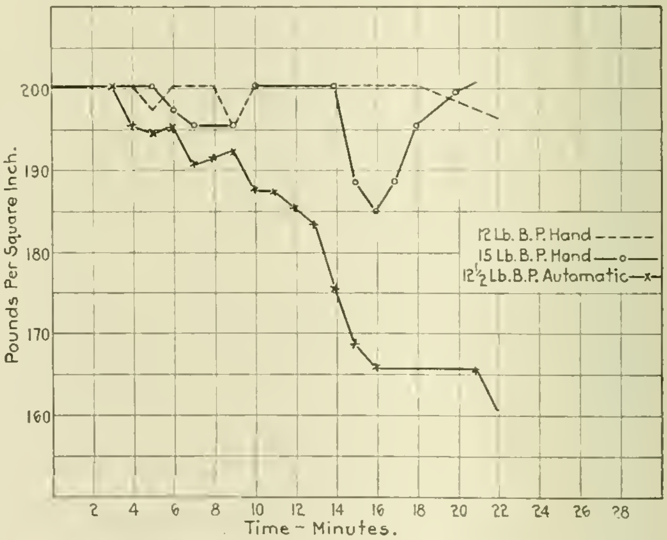


Fig. 11—Steam Pressure on the Three Runs Shown in Figs. 9 and 10

Fig. 10 shows the rate at which the cutoff was changed and the nature of the grades negotiated. In the first 10,000 ft. seven adjustments were made in 11.4 min., or one every 1.6 min., in the first test; six adjustments were made in 9.0 min., or one every 1.5 min., in the second test, and in the third test six adjustments were made in 9.4 min., or one every 1.56 min.

Some time had elapsed between the first and third tests and as a result, the condition of the fire in the test of the automatic device was not as conducive to good steam pressure as in the two previous tests. Since this condition, however, is to be expected no steps were taken to better it. Fig. 11 shows the steam pressure conditions under which the three tests were run and explains why the automatic device held the engine in the corner longer than was required in the first two tests and did not hook back to the same short cutoff that was obtained in the other tests. It is remarkable, however, that in spite of the lower steam pressure the performance practically equalled the first two tests.

The modern locomotive with all the capacity and economy producing specialties and features of design may be divided into two parts by a line extending horizontally under the fire box and through the valve, from tender end sill to pilot beam. Above this line there is every development to produce steam economically and in quantity. Below this line there is every development to utilize the steam and the potential capacity of the entire machine in the production of drawbar pull and gross ton miles—the ultimate justification for the investment The extent to which the ultimate return in capacity and economy is realized depends upon the element of personal skill of the engineer.

The function of cutoff adjustment is the accurate and constant transfer of energy and the extent to which accuracy and constancy are obtained is the measure by which net return is realized.

American Society for Testing Materials

Annual Meeting Discusses Specifications for Cast-Iron Car Wheels; Also Sulphur and Phosphorus in Steel

At the twenty-fourth annual meeting of the American Society for Testing Materials held at Asbury Park, N. J., June 20 to 24 inclusive, a number of papers and committee reports were presented and discussed. Several of the subjects considered and the actions taken are of particular interest to railroad men.

Chilled Cast-Iron Car Wheels

A large part of the evening session of June 24 was taken up with the report of Committee A-3 dealing mainly with specifications for chilled cast-iron car wheels presented by Dr. Richard Moldenke, a paper entitled "Some Failures of Cast-Iron Wheels," by H. J. Force, and a lively discussion which was entered into by many railroad men and representatives of cast-iron car wheel manufacturers who were present.

The paper by Mr. Force was an excellent presentation of the importance of including chemical requirements in the specifications for cast-iron car wheels. An abstract of this paper is printed elsewhere in this issue. The question of including chemical specifications has provoked considerable discussion in the past but up to the present time they have not been included, owing largely to the difficulty of determining the limits of certain elements.

Those who took part in the discussion as representatives of the car wheel makers included George W. Lyndon, president of the Association of Manufacturers of Chilled Car Wheels, which includes 25 companies having a capacity of 25,000 car wheels per day; F. K. Vial, consulting engineer of the association and of the Griffin Car Wheel Company; H. E. McClumpha, National Car Wheel Company; Mr. Courtney, New York Car Wheel Company, and H. C. Brown, Brown Car Wheel Company. All of the manufacturers' representatives who participated in the discussion, recognized the importance of chemical specifications and favored the inclusion of limits, usually very nearly the same as those suggested by Mr. Force. Several stated that they were now manufacturing wheels to similar specifications of their own. Mr. Vial said that in his judgment the amount of combined carbon and the depth of the chill should be included in any specification and that it was vital that there be a proper balance between the elements with combined carbon not over 0.85 to 0.90 per cent and with manganese at least three times the sulphur content. The only serious question raised was how southern and Pacific coast manufacturers would be able to keep phosphorus between 0.30 and 0.40 per cent when their pig iron already ran to 0.50 per cent.

Robert Job. vice-president Milton Hersey Company, Ltd., Montreal, Canada, and formerly with the Lehigh Valley, stated that the proposed specifications were similar to those which had been used on the Lehigh Valley with excellent satisfaction. Repeated analyses which he had made of car wheels which had failed in service showed that combined carbon had exceeded 0.90 per cent and that the phosphorus was over 0.30 per cent and sulphur over 0.15 per cent. C. T. Ripley, general mechanical inspector, Atchison, Topeka & Santa Fe, favored the proposed specifications and also strongly advocated the arch plate pattern wheel, which he said has materially reduced the occurrence of slag inclusions and has minimized the danger of cracked plates. G. E. Doke, engineer of materials, New York Central, Cleveland, O., advocated the suggested chemical specification which he believed would result in better wheels. He also emphasized the need of a thermal test, citing instances of wheels containing 1.02 per cent combined carbon which failed in 150 sec. and wheels of 1.26 per cent combined carbon which failed in 100 sec. in such a test.

Referring to the recommendations of Mr. Force relative to the presence of nickel and chromium, Doctor Moldenke advocated their inclusion in the original pig and not by means of alloys or otherwise. He also emphasized the necessity of closely watching cupola practice and claimed that by the use of the basic electric furnace in conjunction with the cupola, the desired results as to refinement and composition could be obtained by direct action.

By a vote of the society the report of the committee was adopted, including the following chemical requirements:

	Per cent
Combined carbon	0.50 to 0.85
Manganese	0.50 to 0.75
Sulphur	0.18 maximum
Phosphorus	0.30 to 0.40
Silicon	0.45 to 0.75

The tentative specifications for chilled cast-iron wheels embody the well-known A.R.A. requirements with the addition of the above chemical limitations, which is a most important step forward.

Steel Specifications

The report of the Committee on Steel was presented by its chairman, F. W. Waring, engineer of tests, Pennsylvania System, Altoona, Pa. The most important subject taken up was that relative to the allowable limits for phosphorus and sulphur. During the war the limits on these elements in 43 specifications were increased 0.01 per cent on account of the difficulty in obtaining a sufficient amount of suitable melting stock and low sulphur fuels and a note to that effect was added to the various specifications for steel. In 1919 the tolerance was removed from all but 14 of the specifications, on which it was allowed to remain a while longer. The committee recommended that the note relative to allowances now be removed from the remaining specifications and that for three classes of structural steel—namely, those for locomotives, cars and ships—the limit for sulphur be raised from 0.05 to 0.06 per cent due to the heavy tonnage involved and to the continued difficulty in obtaining low sulphur fuels and melting stock. The sulphur tolerance is thus removed from specifications for materials usually worked hot and retained for structural materials generally fabricated cold. For steel castings where the same difficulties still exist, it was recommended that the limit for sulphur be raised 0.01 per cent. The phosphorus requirement for acid steel was also raised 0.01 per cent.

All the recommendations of the committee were adopted. Bessemer steel specifications for rails, splice bars, reinforcement bars, tie plates and track bolts now require conformity to the original specifications for phosphorus. The original sulphur limits are also restored for rivet steel, boiler tubes, seamless tubes and steel chain.

The committee reported that a comprehensive survey of the effects of phosphorus and sulphur in steel castings was well under way in the hands of a large joint committee under the chairmanship of the Bureau of Standards. When this work is completed it is anticipated that important and intelligent action can be taken on the subject of specifications for steel castings.

It was recommended that specifications for the heat treatment of steel forgings and billets be revised. At present the specifications state that forgings should be allowed to become cold after being forged, but it was recommended that they be changed to call for cooling only to a temperature below the critical range.

Other matters which the committee is taking up are specifications for steel sheets, methods of conducting tests and welding requirements, on the last of which it is working in conjunction with the American Bureau of Welding.

Other Papers and Reports

Interesting papers were presented on impact tests of steel castings, strength of steel at high temperatures and magnetic testing of springs by which means it was thought that many defects could be located.

The Committee on Cast Iron in addition to its report on chilled cast-iron car wheels took up the subject of so-called "semi-steel" castings. This is a loose and more or less misleading name given to a very useful form of cast iron. The addition of steel scrap to foundry mixtures dates back to the Civil War and through the reduction of the total carbon, the strength of the castings is thereby greatly enhanced. Specifications for metal of this character are under consideration and it was thought advisable that some other and more distinctive name such as "high test" cast iron be adopted.

Other subjects covered by committee reports included rules for heat treatment, corrosion of iron and steel, specifications for coke, metallography, non-ferrous metals, concrete and reinforced concrete and specifications for steel and wrought iron pipes, tubes and staybolt iron.

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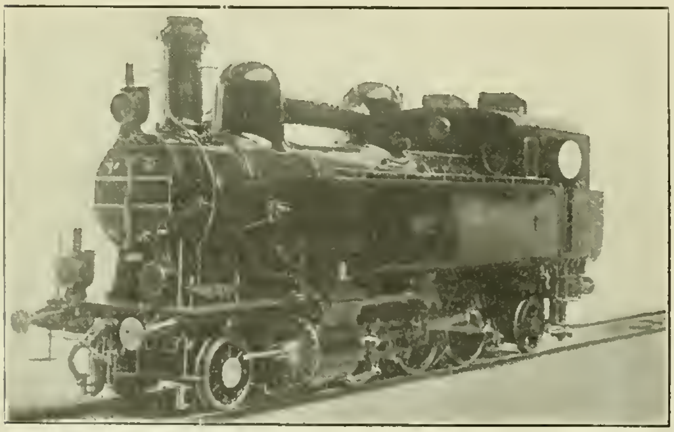
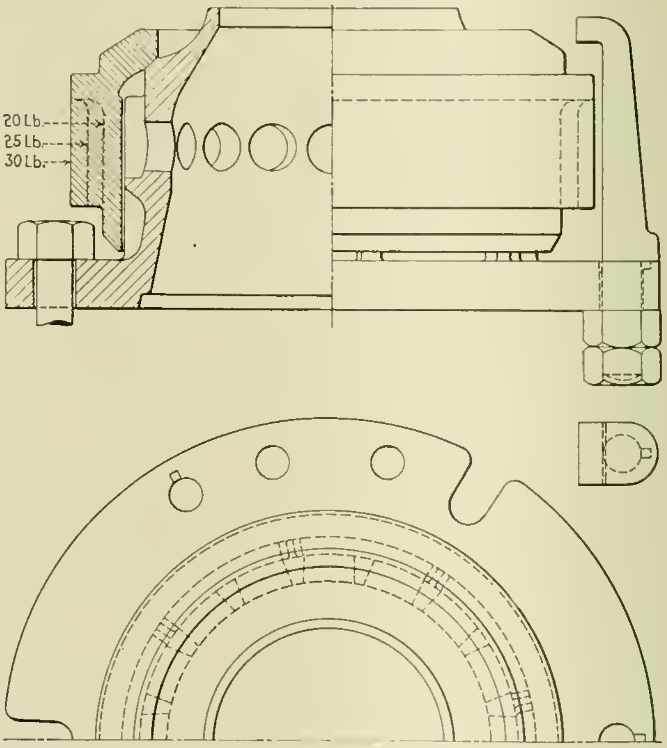

An Austrian Suburban Locomotive

Automatic Variable Exhaust Nozzle

BY CLARENCE ROBERTS

The variable exhaust nozzle has long been looked upon with favor by motive power officers of foreign railways because by its use back pressure in the cylinders can be minimized with a resultant increase in the efficiency of the locomotive.

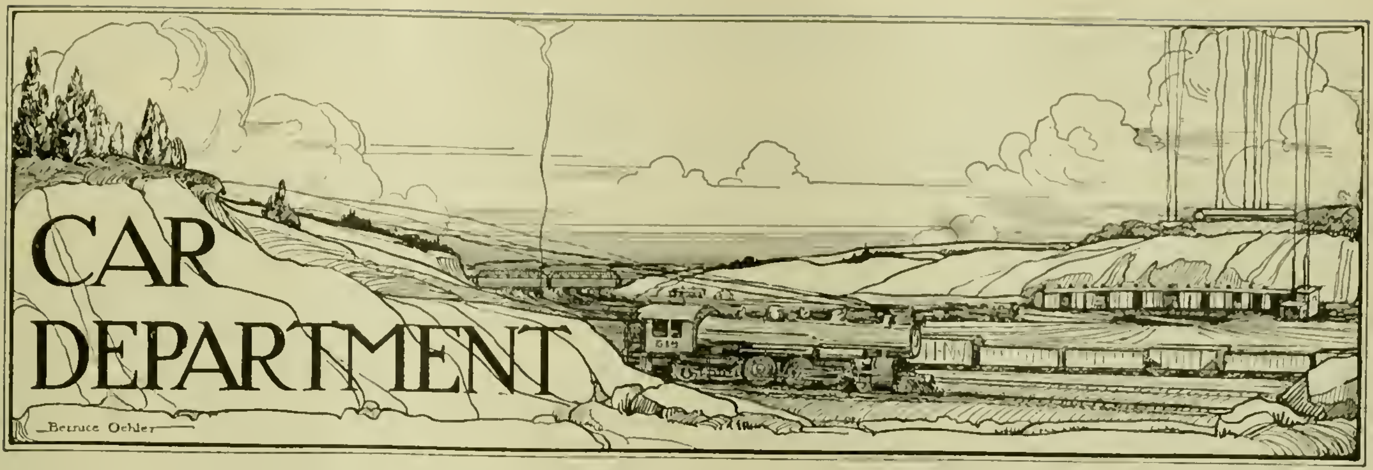
The orifice opening of nearly all variable exhaust nozzles is adjusted by hand regulation under the control of the engineman and with this type, when engine crews receive a bonus for fuel saving, good results are obtained. The Great Western Railway system of England uses an exhaust nozzle known as the automatic jumper blast pipe top and ring in which the varying of the area of the nozzle orifice is automatic, this nozzle having been introduced by G. J. Churchward, chief locomotive superintendent. An idea of its operation may be obtained from the accompanying illustration.



Automatic Jumper Blast Pipe Top and Ring

The device consists of two parts, the nozzle proper and the jumper, or ring surrounding it, there being a chamber between the two. Exhaust steam in addition to passing out of the main nozzle orifice flows laterally through the holes in the wall of the nozzle into the chamber and has a tendency to raise the jumper. When the pressure in the chamber becomes sufficient to overcome the weight of the jumper, it is raised from its seat and an additional orifice is provided in the form of an annular opening surrounding the nozzle. The increase in orifice area of a nozzle of from 4½ in. to 5⅝ in. diameter is 12½ sq. in. The jumper can be designed to raise at any desired exhaust steam pressure by increasing or decreasing its weight.

With proper design the jumper raises, increasing the exhaust steam orifice when the locomotive is starting or when running with long cut-off on heavy grades, etc., the inner nozzle producing sufficient draft to meet average running conditions. Sudden and severe loads do not proportionately increase the back pressure in the cylinders nor tear the fire. For these reasons the use of the device has resulted in fuel economy and increased efficiency of the locomotive.



Factors To Be Considered in Freight Car Designing

Arranging Details to Reduce Cost of Construction and Maintenance; Avoiding Troublesome Defects

BY ALBERT H. LAKE, JR.

TO DESIGN an efficient and economical freight car it must be considered from three different points of view: namely, the purchaser's, the builder's and the operator's. To disregard any of these will result in a poorly designed or expensive car.

There is not and never will be such a thing as a standard car, and the details that will absolutely interchange between all different types of cars are very few. This was conclusively proved by the experiment of the U. S. R. A. in 1918. Such details as hand brake wheel, ratchet wheel, ratchet wheel pawl, rear draft lugs, cylinder push rod, defect and routing card boards and hand brake chain on the body and the brake beam end hangers and dead lever guides on the trucks can usually be made to interchange on all types of cars.

Such details as striking plates, front draft lugs, push pole pockets, body bolster center braces, center plates, side bearings, ladder rounds and uncoupling device can be made to interchange on a few types of cars. However, it is not a good policy to materially sacrifice the design of a car to accommodate details. In addition to these there are the A. R. A. standards that will interchange on all cars of the same capacity. It is nearly impossible and very impractical to design a car and not use patented specialties.

Under Frame and Superstructure

In preparing the design the under-frame is usually considered first. It should be of sufficient strength to carry the rated capacity plus 10 per cent overload, uniformly distributed. For some types of cars, such as flat and drop end gondola, the underframe is also calculated for 75 per cent of the rated capacity distributed over a distance of 10 ft. at the center. This is done to take care of shipments of heavy machinery that may be loaded at the center of the car and for long structural steel girders supported at the center of two adjacent cars.

The area of the center sills and the ratio of stress to end load must meet the A. R. A. requirements. For steel frame box cars where the side frames can be made to carry the load, rolled channels should be used for center sills. Fish-belly sills are sometimes used, but they add unnecessary weight, and while they were used extensively in the past have now become practically obsolete. Fish-belly sills, built up of plates and angles, give good satisfaction and are more economical as the flange angles can be made heavy and the web plate light, giving a better distribution of metal than can be obtained in the pressed sill.

Rolled Z-bars are the most economical and are usually used for the side frames of single-sheathed box cars, although pressed steel members have given good results. A better connection at the side sill and side plate can be obtained when pressed posts and braces are used, although there is an objection to this construction due to the fact that it is difficult for any railroad other than the owner to make repairs.

The ends of box and gondola cars should receive special consideration. Corrugated ends for box cars have given satisfaction, but care must be exercised to connect them properly at the sides and bottom. If wood construction is used the posts at the center must be designed with a high section modulus at a point about 30 in. above the floor, as this is where the maximum bending movement will occur. Pressed steel end posts have been used with good results. For solid end gondola cars, the ends are usually made of the same material as the sides, although corrugated steel ends have been used on a large number of cars of composite construction and have given satisfaction. In any case, they must be rigidly reinforced and securely fastened at the corners. For drop ends, a number of types of construction may be used. However, the corrugated steel drop end is the most extensively employed type. Hinges and locking devices should be carefully designed and the doors rigidly reinforced.

Large end doors on automobile cars has been practically discontinued in favor of wide side doors. Such side doors are usually made in two sections and so arranged that for ordinary shipments only one section need be opened, while for loading automobiles both sections are opened. The main reason for discontinuing end doors is that it is next to impossible to build and maintain them so that they will withstand the shocks of shifting loads when the cars are used for shipments other than automobiles.

On many gondola cars the side stakes are weak and permit the sides to bulge at the center. This can be overcome by using pressed steel stakes with a large section modulus at the top of the side sill, and extending those at the cross-bearers down as far as possible and securely riveting them to the cross-bearers and side sill.

Cross ties near the top of hopper cars have never given satisfaction and should not be used. If bulb angles are used on the top of the sides and properly designed gussets applied at the cross-bearers and bolsters, the cross ties can be omitted and a more satisfactory car obtained.

Side doors and roofs are usually designed by specialty companies, but they should be carefully selected to suit the needs of the car under consideration. Bottom-hung doors are extensively used and give satisfaction. Side-door locks and bottom guides should be so designed and applied that burglars cannot gain admittance to the car. Door starters should be applied and spark strips and top guides or tracks so designed that the door will be weather proof.

A flexible metal roof laid over wood sheathing makes a satisfactory job. An all-steel roof is also extensively used.

Draft Gear

The draft gear seems to be about the weakest part of most cars and because of the limited space it is sometimes almost impossible to make it meet the A. R. A. recommendations. Combined striking plate and front draft lugs are sometimes used to advantage; also, a combined striking plate and carrier iron. The recommended shearing area of 15 sq. in. and bearing area of 7½ sq. in. for draft gear attachments should be maintained. Therefore, there should not be less than 13 rivets of ⅞ in. diameter in each draft lug, and the draft sill or draft lug should not be less than ⅜ in. thick. With the existing standard of 21¼ in. from the coupler horn to the front follower, it is very difficult to get 13 rivets in each front draft lug. If this distance could be increased to 24 in. or 25 in., it would materially help the condition. In some tight places the horizontal forged yoke and check plates can be used to advantage.

The composite type of construction for gondola cars has proved satisfactory and some composite hopper cars have been built recently. The advantage of this type of construction is that the sides and floors can be renewed or repaired readily. Stake pockets should be applied to gondola cars. If they are applied on the inside they should be of the collapsible or disappearing type, as the rigid type is easily damaged and will not give good service. On flat cars, stake pockets must be applied and should be spaced not less than 2 ft. 0 in., nor more than 3 ft. 6 in. apart, to meet the A. R. A. rules of interchange.

Hopper car floors should be rigidly reinforced by angles or other means to prevent them from sagging on each side of the bolster, often a weak point in hopper cars.

Hopper and general service car door operating mechanisms should be so designed that it will be impossible for the operator to be injured while opening or closing the doors. In closing the doors the operating handle or lever should always work downward.

Brake Rigging

The design of the foundation brake gear should be carefully checked. The A. R. A. recommendations should be used: that is, braking power 60 per cent of the light weight of the car; cylinder pressure 50 lb. per sq. in.; maximum fiber stress for levers, 23,000 lb. per sq. in.; maximum fiber stress for rods, 15,000 lb. per sq. in.; maximum shearing stress for pins, 10,000 lb. per sq. in.

All rods, levers and pins are to be designed for an overload of 60 per cent or a cylinder pressure of 80 lb. per sq. in. The cylinder should be so located and the levers so proportioned that there will be no side movement of the cylinder push rod. If possible, pockets in the brake pipe should be avoided. The pipe should be securely clamped to prevent end shifting. The use of patented angle cock holders is desirable, but not absolutely necessary. The retaining pipe must be securely clamped and the retaining valve properly located.

The hand brake should be so designed that the hand braking power will equal the air braking power. This can be accomplished by the addition of an extra lever, by gears, or sometimes by adding a sheave wheel. The type of car under consideration will largely determine whether the ordinary brake wheel or a ratchet lever should be used. On flat and drop-end gondola cars, a drop brake mast is often used to permit the loading of long material on two or more cars. Several designs of drop-brake masts are on the market and they should be carefully selected.

The brake should be laid out in both full release and full piston travel positions to make sure that all lever guides are of sufficient length and to determine all other clearances with the car body. Cylinder and reservoir supports and lever fulcrums should be of ample strength to carry the loads to which they are subjected.

Trucks

The type of trucks chosen is largely a matter of cost, or conforming to existing standards, but they should be selected to meet the requirements of the car. Brake beams should be carefully selected and properly hung and provided with a third point suspension to guard against the brake shoes wearing tapered. Side bearings must be properly spaced and should be preferably of the roller or frictionless type. Wood spring seats should not be used, as they will not stand up under the continued action of the springs. When wheels are turned the center plate height should be maintained by the addition of metal shims under the center plate or springs, or by the addition of new metal spring seats.

Safety appliances should always meet the I. C. C. requirements with a safe margin to take care of variations in building and small damages in service. The coupler operating mechanism lifting bar should connect directly to the coupler operating eye without the use of chains or clevises. The single lever push-down type is economical and efficient and can be operated by brakemen while riding on the sill step, which is a great advantage in switching in yards where there is no hump.

The hand brake ratchet wheel and pawl must be carefully considered. The ordinary pawl must always be arranged to be operated by the brakeman's left foot. The gravity pawl is efficient and has many operating advantages.

The design of details should be closely watched. If fish-belly center sills are used, there will be a large amount of scrap plate available for small gussets and connections. It also can be pressed into angles and used in place of the customary rolled angle connections. Therefore, on designs where there will be considerable scrap plate, as many gussets and connections as possible should be made of the same thickness as the scrap.

The number of dies required in the building of cars is an important item. There should be no hesitation in using pressed details, but the details should not be made different when it is possible to make them the same. Such details as the bolster and cross-bearer diaphragms can often be pressed on the same die; in addition the shallow diaphragms can often be made all one-hand instead of "as shown, and reverse." By looking out for such points as this it will often be possible to save the expense of making new dies.

Specialties should be selected with great care. The following three points should govern such selection: adaptability, durability and cost. Every car should be equipped with all necessary appliances, but should not be loaded down with unnecessary devices to please some specialty manufacturer.

Draft Gear Tests of the Railroad Administration

Results of Car Impact Tests, Comparative Grading of Gears and General Conclusions

A VARIETY of interesting curves may be derived from the car-movement curves, but the essential features of the functioning of the gears are shown in the following, which were reproduced for each of the three runs for each type of gear:

MASTER CURVES
Car-Movement Curves—Superimposed
DERIVED CURVES
Velocity Curves
Energy Curves
Time-Force Curves
Time-Closure Curves
Force-Closure Curves

A brief discussion of each of these curves will serve to illustrate their use in analyzing the action of the gears.

Car Movement Curves—Superimposed

Irregularities in the car-movement curves are due in a large measure to the vibration or to the relative movement of the side sills. The effect of these vibrations upon the car-movement curves, is probably the best comparative measure of the smoothness of action of the draft gears that can be obtained, for the smoother the action of the gear the more gradual and regular will be the transfer of energy from the striking car to the standing car and the less will be the vibrations of the car structure. The other data derived from these curves has already been discussed.

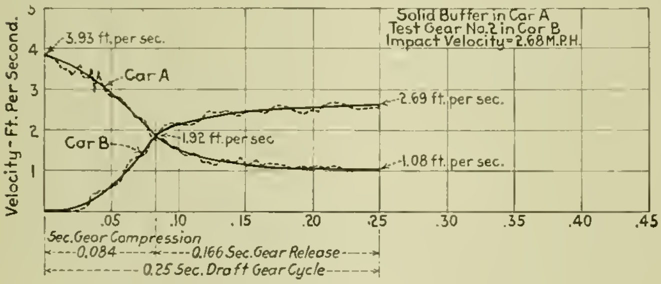


Fig. 1—Velocity Curves, Westinghouse D-3 Gears

Velocity Curves

Fig. 1 shows the derived velocity curves for the single-gear run of the Westinghouse D-3 gear at the closing speed. The irregular dotted line shows the exact first derivatives of the car-movement curves, the first derivative being instantaneous velocities. Any slight irregularity in the car-movement curve becomes very apparent in this curve. The curves for the Westinghouse D-3 gears are unusually smooth for its capacity.

The impact velocity of car A in this run was 3.93 feet per second (2.68 M.P.H.), the velocity of car B at this instant being zero. As the gears compressed, the velocity of car A decreased and the velocity of car B increased until at the instant of maximum gear compression both cars were of the same velocity, namely, 1.92 feet per second. The result of the closing of this gear, therefore, was to reduce the velocity of car A from 3.93 feet per second to 1.92 feet per second. The remainder of the change in velocity of the two cars is due to the recoil of the gear, the effect of the recoil being to increase the velocity of car B to 2.69 feet per second and to still further reduce the velocity of car A to 1.08 feet per second at parting.

The irregularities in the velocity curves are due largely to the local surging and vibrations of the side sills. With a spring draft gear, and with some of the lower capacity friction gears, the transfer of motion from one car to the other is effected with practically no disturbance of the car structure, the velocity curves being relatively smooth. On the other hand, with the higher capacity gears, considerable vibrations are set up. It is not to be expected that a gear functioning up to, say, 4 miles per hour, will give as smooth and regular a veloicty curve at its closing speed as one functioning only to 2 miles per hour. The point of real interest is to compare the relative smoothness of these curves from gears of the same capacities and at approximately the same impact speed. Draft gears should be tested upon actual cars so that if a gear has a tendency to pinch and bind on compression, it will be developed and discovered.

These vibrations in the velocity curves should not be interpreted as meaning that the side sills of the cars vibrated through such distance. The actual movement of the side sills that occurred were very slight; in many instances barely more than a tremble and seldom more than 1/8 in. Mean velocity curves, shown in full lines, have been established from the general trend of the original car-movement curves, and these represent, as closely as it is practical to obtain, the true mean velocity of the entire mass of the car. This mean velocity curve is used throughout the remainder of the cards for the determination of energy and force.

Energy Curves

The energy curves shown in Fig. 2 have been produced by simple calculation from the preceding velocity curves. These energy values include not only the kinetic energy represented by the direct movement of the car as a whole, but also the energy of rotation of the wheels and axles.

In this particular run (Westinghouse D-3 single gear at closing speed) the kinetic energy of car A was reduced from 35,308 ft. lb. to 8,427 ft. lb. by the compression of the gear, while at the same time the kinetic energy of car B was increased from zero to 8,427 ft. lb. The sum of the kinetic energies of the cars at this instant, (the instant of maximum draft gear compression) amounted to 16,854 ft. lb., so that the work done in compressing the draft gear and the car structure, and in overcoming rolling and grade resistance, amounted to 18,454 ft. lb. This quantity corresponds with the expression "work done" as applied to drop testing of draft gears. The dotted line beneath the line of zero energy represents the instantaneous value of work done at any instant during draft gear compression up to the instant of maximum draft gear closure.

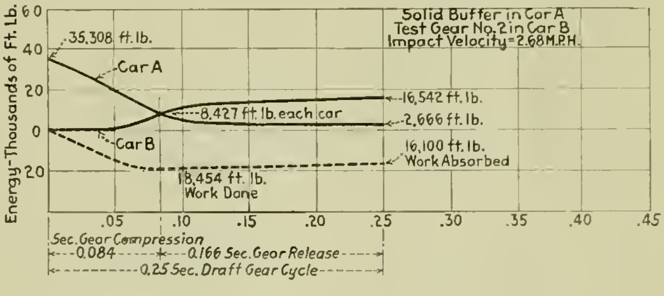


Fig. 2—Energy Curves, Westinghouse D-3 Gears

The energy curves during the period of draft gear release show the changes in kinetic energy produced in the cars by the recoil of the draft gear. In this particular run the recoil increased the kinetic energy of car A to 16,542 ft. lb. and reduced that of car B to 2,666 ft. lb., so that at the instant of parting the kinetic energy represented by the movement of the two cars amounted to 19,208 ft. lb. The original kinetic energy of car A being 35,308 ft. lb., there was thus a total sbsorption in this run of 16,100 ft. lb., this quantity corresponding with the expression "work absorbed" as applied to drop testing of gears.

The maximum possible absorption of this run was 18,454 ft. lb., the work done in closing the gear; and as the absorption amounted to 16,100 ft. lb., the percentage of gear absorption in this run was 87.2 per cent.

Time-Force Curves

Fig. 3 shows the mean forces which develop between the two cars due to draft gear compression and relcase. The force is plotted against time, and the curve thus shows the building up of the force throughout the period of compression, to a peak at the point of maximum gear closure. During the release period the force falls off suddenly in the case of a friction gear.

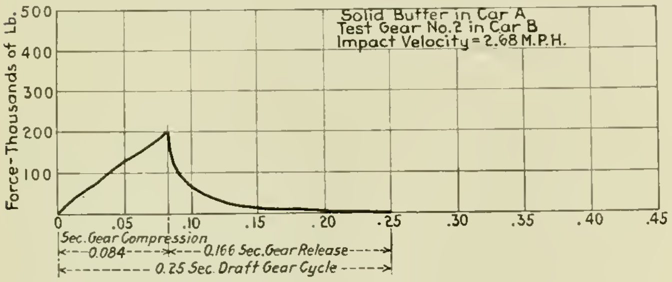


Fig. 3—Time-Force Curves, Westinghouse D-3 Gears

The portion of the time-force curve to the left of the peak denotes mean draft gear compression forces while that to the right denotes the forces of release. The force has been obtained by calculating the forces required to produce the recorded changes of velocity over a given period of time. It is unquestionable that in many of the gears, probably in every case, the sticking and irregularity of gear closure was accompanied by high forces which, because of their very limited duration, could not manifest themselves in the time-displacement curves. The mean or average forces and the ultimate peak forces as deduced in these curves, however, are substantially correct and it is questionable whether after all the mean force as depicted, or in other words the force supplied over long enough period of time to produce penetration or to do the work of rupture, is not the real damaging factor.

The time-force curves will assist in an understanding of the fact that the force between colliding cars is not governed or in any manner reduced by the action of a friction gear over a spring gear of the same characteristics. Energy absorption has in itself no effect whatever upon the compression line. But its influence is immediately apparent in the forces of release. For while it requires high forces to overcome the frictional resistance and to compress a friction gear, the force immediately disappears when the gear starts to release. This action is clearly shown in the time-force curves.

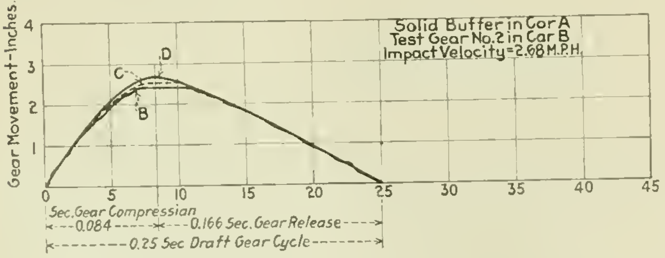


Fig. 4—Time-Closure Curves, Westinghouse D-3 Gears

Time-Closure Curves

Time-closure curves are developed for each of the runs, Fig. 4 showing such a curve for the single gear run for the Westinghouse D-3 gear. Curve D in this figure has been derived and erected from the superimposed car-movement curves and shows the full yield that took place between the cars, including draft gear compression, center sill compression, and side sill movement. Curve C is obtained by subtracting from Curve D the amount of the center sill yield and side sill movement. Curve C therefore represents the amount of and nature of the true draft gear action, all other influences being eliminated. Curve B was obtained from an entirely different source, namely, from the small drum carried by car B for recording the action of the draft gear in that car.

The time-closure curves of the runs in which both cars were equipped with draft gears showed that the two gears did not act in an entirely uniform manner, but that occasionally one of the gears would cease acting for an instant while the other moved. At other times both gears were acting. This character of action occurred both on compression and release, and was visible to the eye when closely watching the movement of the buffers.

Force-Closure Curves

In Fig. 5 is shown a force-closure curve for the closing run of Westinghouse D-3 gear (single gear run). This curve is produced directly from the time-force curve, Fig. 3, and the time-closure curve, Fig. 4, by eliminating the time element from both of these curves and plotting the force directly against gear closure. The diagram corresponds with the ordinary static card except that it represents the dynamic action of the gear.

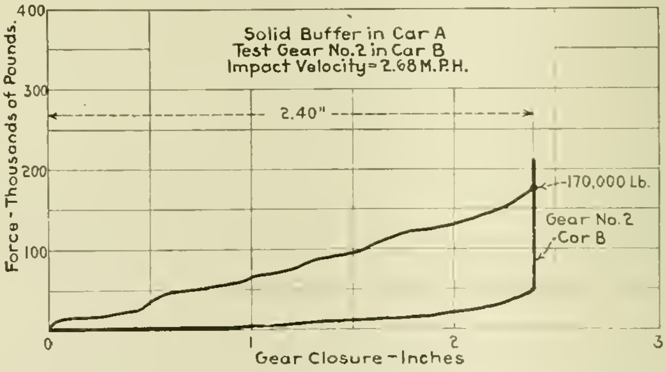


Fig. 5—Force-Closure Diagrams, Westinghouse D-3 Gears

The amount of work done and work absorbed may be

Classification of Gears According to Closing Speed

Class 1: Gears closing at 5 M.P.H and over
  National Type H-1.
Class 2: Gears closing at from 4 to 5 M.P.H.
  Sessions Type K.
  Miner Type A-18-S.
  Westinghouse Type NA-1.
  National Type M-1.
  Sessions Jumbo.
  National Type M-4.
Class 3: Gears closing at from 3 to 4 M.P.H.
  Cardwell Type G-18-A.
  Cardwell Type G-25-A.
  Westinghouse Type D-3.
  Gould Type 175.
  Christy.
  Miner Type A-2-S.
Class 4: Gears closing at less than 3 M.P.H.
  Waugh Plate.
  Bradford Type K.
  Harvey, Two 8 in. by 8 in. springs.
  Coil Springs, two 8 in. by 8 in., Class G.

figured from this card in the same manner as from the ordinary static card, these figures being given in later tabulations.

CLASSIFICATION OF GEARS.	MAKE AND TYPE OF GEAR	TEST GEAR NUMBER		ACTUAL VELOCITY M.P.H.			SEISMOGRAPH READINGS		DISTANCE CARS TRAVELED FROM POINT OF IMPACT FT.		AMOUNT OF DRAFT GEAR CLOSURE INCHES.		YIELD OF TWO CAR BODIES - INCHES.	TIME-SECONDS			TRACK MOVEMENT OF CARS DURING D.G. CYCLE — INCHES	KINETIC ENERGY IN CARS FT. LBS.			ENERGY LOSS DURING D.G. CYCLE FT. LBS.	DETAILS OF ENERGY LOSS FOOT LBS.			ENERGY RETURNED BY 2 DRAFT GEARS FT. LBS.	WORK DONE BY 2 DRAFT GEARS FT. LBS.	ABSORPTION EFFICIENCY OF GEARS	FORCE TRANSMITTED TO CAR SILLS BY DRAFT GEARS. LBS.
		CAR A	CAR B	IMPACT CAR A	PARTING CAR A	CAR B	CAR A	CAR B	CAR A	CAR B	CAR A	CAR B		COMPRESSION	RELEASE	TOTAL OF D.G CYCLE		AT IMPACT CAR A	AT PARTING CAR A	CAR B		TRACK AND GRADE RESISTANCE	ABSORBED BY 2 CAR BODIES	ABSORBED BY 2 DRAFT GEARS				
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭	⑮	⑯	⑰	⑱	⑲	⑳	㉑	㉒	㉓	㉔	㉕	㉖	㉗	㉘	㉙
5 M.P.H. AND OVER	NATIONAL H-1	30	29	5.07	1.25	3.70	5.9	6.0	10'-1"	43'-2"	2.46	2.59	17	.091	.155	.246	10.5	126300	7639	67200	51461	2133	7828	41500	12867	54367	76%	550000
4 M.P.H. TO 5 M.P.H.	SESSIONS K	12	11	4.37	1.27	2.95	4.4	4.2	12'-11"	29'-6"	2	2.06	.31	.095	.187	.282	10.7	93820	7930	42850	43040	2213	8077	32750	5983	38733	85%	260000
	MINER A-18-S	24	23	4.46	1.17	3.19	4.6	4.4	11'-1"	37'-10"	2.61	2.61	17	.098	.207	.305	11.7	97800	6160	50050	40990	2617	11706	26667	10766	37433	71%	390000
	WESTINGHOUSE NA-1	8	7	4.16	1.22	2.80	4.1	3.8	12'-11"	27'-10"	3.05	2.91	.16	.124	.287	.411	14.8	85100	7320	38410	39370	3268	2669	33433	4901	38334	87%	187000
	NATIONAL M-1	33	32	4.26	1.21	3.18	4.3	3.9	11'-5"	32'-5"	2.61	2.61	.19	.104	.231	.335	12.4	89591	7203	42076	40312	2805	3940	33567	6433	40000	84%	404000
	SESSIONS JUMBO	15	14	4.30	1.01	3.20	4.7	4.4	9'-9"	31'-8"	3	2.83	.17	.121	.226	.347	13.8	90740	5030	50050	35660	3105	3922	28633	9417	38050	75%	250000
	NATIONAL M-4	36	35	4.12	1.22	2.76	4.1	3.7	12'-3"	26'-9"	2.55	2.42	.13	.111	.244	.355	12.7	83620	7330	37620	38670	2910	4127	31633	5300	36933	86%	159000
3 M.P.H. TO 4 M.P.H.	CARDWELL G-18-A	21	20	3.85	1.19	2.49	2.9	2.8	12'-4"	25'-9"	3.21	3.21	.16	.144	.358	.508	16.7	72930	6946	30508	35476	3437	889	31150	3083	34233	91%	186000
	CARDWELL G-25-A	18	17	*4.05	1.22	2.67	3.7	3.3	12'-6"	28'-6"	2.73	2.79	.14	.116	.280	.396	14.0	80638	7317	35131	38190	3086	4037	31067	4766	35833	87%	315000
	WESTINGHOUSE D-3	3	2	3.65	1.01	2.42	3.1	3.1	9'-4"	24'-6"	2.52	2.43	.11	.112	.235	.347	10.9	65437	5235	30338	29864	2329	3202	24333	5000	29333	83%	240000
	GOULD 175	42	41	3.56	.80	2.66	3.5	3.4	6'-0"	26'-11"	2.57	2.40	.18	.114	.213	.327	10.0	62295	3124	34648	24523	1928	2395	20200	7334	27534	73%	260000
	MURRAY H-25	39	38	3.45	.91	2.32	2.6	2.6	7'-5"	21'-7"	2.76	2.45	.16	.127	.270	.397	11.6	58419	4105	26584	27730	2588	1975	23167	4633	27800	83%	210000
	CHRISTY	53	52	3.73	1.09	2.44	3.1	3.2	11'-9"	23'-2"	2.07	2.23	.17	.104	.235	.339	11.1	68230	7018	29186	32026	2295	7914	21817	4050	25867	84%	194000
	MINER A-2-S	27	26	3.21	.88	2.12	2.0	1.8	7'-0"	17'-0"	2.59	2.45	.27	.138	.287	.425	11.6	50615	3760	22101	24754	2560	5361	16833	3217	20050	84%	105000
LESS THAN 3 M.P.H.	WAUGH PLATE	50	49	*3.02	.43	2.52	2.8	3.0	23"	24'-4"	2.32	2.30	.16	.116	.176	.292	7.6	44866	928	33120	10818	1483	1102	8233	9967	18200	45%	335000
	BRADFORD K	47	46	2.78	.28	2.37	2.5	2.2	14"	21'-2"	2.52	2.38	.16	.137	.186	.323	7.6	37927	397	27695	9835	1482	4053	4300	9366	13666	31%	270000
	HARVEY 2-8"x8" SPGS.	56	55	2.33	.32	1.92	1.7	1.6	16"	14'-9"	1.97	1.76	.12	.117	.179	.296	5.9	26647	523	18050	8074	1328	1329	5417	4566	9983	54%	300000
	COIL SPGS. 2-8"x8" CL. G.	59	58	1.84	0	1.71	1.0	1.0	6"	10'-4"	1.94	1.86	.01	.175	.181	.356	5.7	16666	0	14461	2205	1279	26	900	7333	8233	11%	60000

Fig. 6—Tabulation of Car-Impact Tests. Closing Speed Runs. Double Gear Tests. 143,000-Lb. Cars.

A series of runs was also made with both cars equipped with solid steel blocks in place of draft gears to determine the yield of the center sills, the whip of the side sills and the work absorbed by the car bodies and the lading.

Summary of Car-Impact Tests

The general tabulation, Fig. 6, has been prepared to summarize the actual performance of the test gears in the closing-speed double-gear runs of the car-impact tests. In this tabulation the gears appear in the order of the closing speeds of the commercial gears and have been classified according to closing speeds. In studying the performance of the car and the action of the gears there is but little interest in comparing a low speed gear with a high speed gear. The interest lies in comparing the action of and the results from the use of gears of different types and of approximately equal capacities. To facilitate such comparisons the various gears have accordingly been grouped into the four general classes shown in the accompanying tabulation.

While the Cardwell G-25-A test gears actually closed at 4.05 M.P.H., yet the average commercial gears of this type properly fall in Class 3, and this gear has accordingly been entered in this class in the general tabulations. Likewise the test gears of the Waugh type actually required 3.02 M.P.H. to close them, but from the average commercial gear this type belongs in Class 4. Asterisks (*) have been placed opposite these gears in the tables because of this fact. These tables need no special explanation.

Results to Be Expected from Commercial Gears

In Fig. 7 are shown energy curves for cars of different weights, the rotative energy or fly-wheel effect of the wheels and axles, which amounts to an addition of approximately 3 per cent, being included. Horizontal lines representing the closing points of the various gears have been located on this diagram so that the value of any gear upon cars of the different weights may be readily obtained. These horizontal lines for the several gears are based upon the action of the average commercial gear. By means of this diagram the application of the results may be readily converted from a specific case to general cases.

Grading of Average Commercial Gears

Any one familiar with draft gear operation and testing can from the foregoing results, establish his own rating of the gears. The relative total merits of the types will differ, depending upon the importance attached to the several features of gear action. No one gear excels in all points. One represents the highest capacity; another the highest percentage of absorption; another the highest degree of smoothness of action.

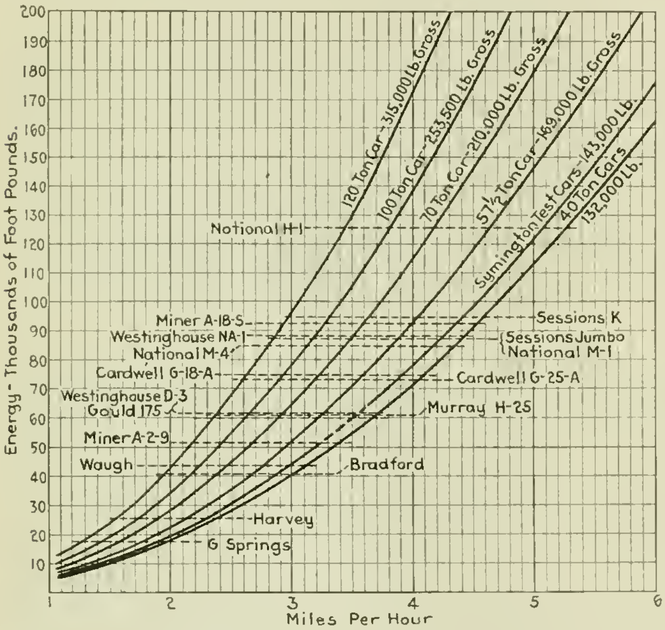


Fig. 7—Energy Curves for Cars of Various Weights, with Commercial Gear Capacities Indicated

The tabulation, Fig. 8, has been prepared on the basis of the following relative weights or percentages for the several phases of gear performance:

Capacity	50	points
Smoothness of action	15	"
Closing pressure	5	"
Absorption	15	"
Oversolid sturdiness	10	"
Workmanship and general operation	5	"
Total	100	"

The gradings on the above basis are made directly from the test results, except for the last item of five points, which represents those features that it is impossible to denote in abstract figures.

Comparison of the Different Methods of Testing

In most gears a wide difference appears between the static test results and the dynamic results, but in general there is not a wide difference between the drop test results and those in the car-impact tests. Static tests in general are usually made to determine the ultimate resistance of the gear, and the work done and work absorbed. It has generally been supposed that the character of the compression line was indicated by the static tests. These present tests show that the static test is not a measure, either absolute or comparative, of work done, work absorbed or ultimate resistance. For example, in the static test the Westinghouse D-3 gears averaged 18,550 ft. lb. of work done, while in the drop test the average work done was 15,375 ft. lb., the static capacity being 12 per cent higher than the drop capacity. On the other hand, in the National M-1 gear the static result is 263 per cent higher than that of the drop test. No uniformity whatsoever obtains in this percentage.

With some few exceptions, the drop test results, as to capacity and absorption, show a fairly uniform relationship to the car-impact results, the latter in general being from 5 per cent to 20 per cent higher than the drop test results. The drop test accordingly would appear to be a fair comparative measure of draft gears for capacity and absorption.

CLASSIFICATION OF GEARS	MAKE AND TYPE OF GEAR.	CAPACITY. 50 POINTS.	SMOOTHNESS. 15 POINTS.	ULTIMATE FORCE. 5 POINTS.	ABSORPTION. 15 POINTS.	STURDINESS. 10 POINTS.	WORKMANSHIP AND GENERAL OPERATION. 5 POINTS.	TOTAL
①	②	③	④	⑤	⑥	⑦	⑧	⑨
CLASS 1 5 M.P.H. & OVER	NATIONAL H1	50	7	3	12	10	5	87
CLASS 2 4 M.P.H. To 5 M.P.H.	WESTINGHOUSE NA-1	36	15	4	15	3	5	78
	MINER A-18-S	38	8	3	13	6	5	73
	NATIONAL M1	36	9	3	13	7	5	73
	NATIONAL M4	35	8	5	14	5	5	72
	SESSIONS JUMBO	36	9	4	13	3	4	69
	SESSIONS K	38	2	4	13	1	2	60
CLASS 3 3 M.P.H. To. 4 M.P.H.	CARDWELL G-25-A	30	11	4	15	2	3	65
	CARDWELL G-18-A	30	9	4	15	2	4	64
	WESTINGHOUSE D3.	25	11	4	14	3	5	62
	MURRAY H-25	25	10	4	14	3	4	60
	MINER A-2-5	21	10	5	14	5	5	60
	GOULD 175	25	8	3	12	3	4	55
	CHRISTY	24	5	4	14	6	1	54
CLASS 4 LESS THAN 3 M.P.H.	WAUGH PLATE	18	10	1	8	2	5	44
	HARVEY 2-8"x8" SPRINGS	10	5	1	9	3	5	33
	BRADFORD K	16	7	2	5	1	1	32
	COIL SPRINGS 2-ARA-CLASS G	7	4	3	2	2	5	23

(A word of caution is necessary in using this table. While in most cases the results of the tests are believed to be representative of the action of the commercial product, certain exceptions are noted: namely, Cardwell G-25-A, Murray H-25, Bradford K and Christy.—Editor.)

Fig. 8—Grading of Gears, Based Upon Performance of New Commercial Gears

The following general conclusions are drawn from a comparison of the action of the gears throughout the different tests:

1. That the speed of static testing within the limits of the average testing machine has in general but little influence upon the ultimate resistance of the gear.

2. That gears of a type may vary greatly in the static test and at the same time be of approximately equal capacity under the drop.

3. That the static capacity of a gear is no indication whatsoever of its dynamic capacity.

4. That in general, friction gears show greater capacity and higher ultimate resistance in the static test than in any other test.

5. That the ratio of ultimate resistance to work done varies but slightly as between different gears of the same type in the static test.

6. That the ultimate resistance in the static test and in the car-impact test is in general closely proportional to the work done by the gear in these two tests.

7. That the ultimate resistance in the car-impact test and the computed ultimate resistance in the drop test are in reasonably close proportion to the relative amounts of work done by the gear in these two tests.

8. That in the majority of cases the static curve shows the characteristics of the dynamic action of the gear, but that it is not a true measure of its dynamic capacity or ultimate resistance.

9. That the drop test, with a single gear supported upon the solid anvil, is in general a fair comparative test of gears as to dynamic capacity.

10. That the car-impact results will in general be greater than the drop test results by from 10 per cent to 20 per cent.

11. That the relative recoil of gears may be satisfactorily measured under the 9,000 lb. drop.

12. That neither the drop test, the static test, nor any other test using inelastic means for closing the gear will disclose roughness or irregularity of gear action: That tests upon a resilient body such as a standard car will alone disclose this feature of gear action.

The car-impact tests themselves have established and confirmed numerous principles of gear and car action, among which may be noted:

1. The relative merits of the different methods of draft gear testing.

2. The exact impact velocities at which the various gears will cease to offer further protection to the cars.

3. The production of complete dynamic cards of gear action.

4. The independent and inharmonious action of gears when dynamically closed in opposition to each other.

5. That gear action and car action in practice are not smooth and regular, even with the best friction gears.

6. That a friction gear is necessary for obtaining capacity and for eliminating recoil.

7. That the yield of the car structure and the lading do not afford any material aid in the dissipation of energy, and that friction draft gears in modern cars are essential to avoid high forces and early failure of parts.

8. That preliminary spring action shows no especial value in buffing and that heavy initial gear compression is not disadvantageous.

9. That the force developed between cars in buffing is due to the inertia of the cars, and when the slack is not bunched is the same whether the struck car be standing alone or whether it be at the head of a draft of cars; that the force is practically the same whether the struck car be standing with or without the brakes set.

10. That there is a positive displacement of the center sills relative to the side sills of a car, the amount of which is dependent upon the character of the construction tying these members together.

11. That in a modern steel car, a force equal to the ultimate resistance of the highest capacity gear in these tests will be developed between cars, without draft gears, at an impact velocity of 1½ miles per hour.

12. That if a gear is properly constructed as to sturdiness it requires but a slight over-solid speed to produce a high force peak; conversely, if a gear is not sturdily constructed an over-solid blow may never produce a high force peak, but such over-solid blows will quickly deteriorate the gear, and so reduce its efficiency that low impact speeds will cause damage to the car.

13. That the average period of draft gear compression with a friction draft gear is equal to approximately 1/3 of the entire cycle of impact and that the release occupies approximately 2/3 of the cycle. The maximum period of impact experienced was approximately ½ second.

14. That with a spring draft gear the period of compression and of release are approximately equal and that the spring returns practically all of the energy, bringing the striking car to complete rest and imparting almost the original velocity of impact to the struck car.

15. That several acceptable draft gears are now available capable of protecting a 57½-ton car up to a switching speed of 4 M.P.H. Furthermore, that there is not an occasion for higher switching speeds than 4 M.P.H.

General Deductions

From the tests as a whole the following general deductions can now be made and are recommended by the Inspection and Test Section of the United States Railroad Administration:

1. That for use on any car a gear should be selected which will not go solid at less than 3½ M.P.H. nor more than 4½ M.P.H. when the weight of the particular car to which it is to be applied is considered together with the complete information given in this report.

2. That there is no advantage in buffing from preliminary spring action, and that a draft gear should preferably be under some initial friction compression; not only for the increased capacity effected, but also to hold the friction elements in positive engagement at all times, in order to provide a greater latitude of wear and to prevent the deposit of foreign material upon the friction surfaces.

3. That draft gears should have an effective area for receiving over-solid blows slightly greater in extent than the area of the coupler shank; that this area should be presented in direct line with the force and should preferably be relieved of all other draft gear forces.

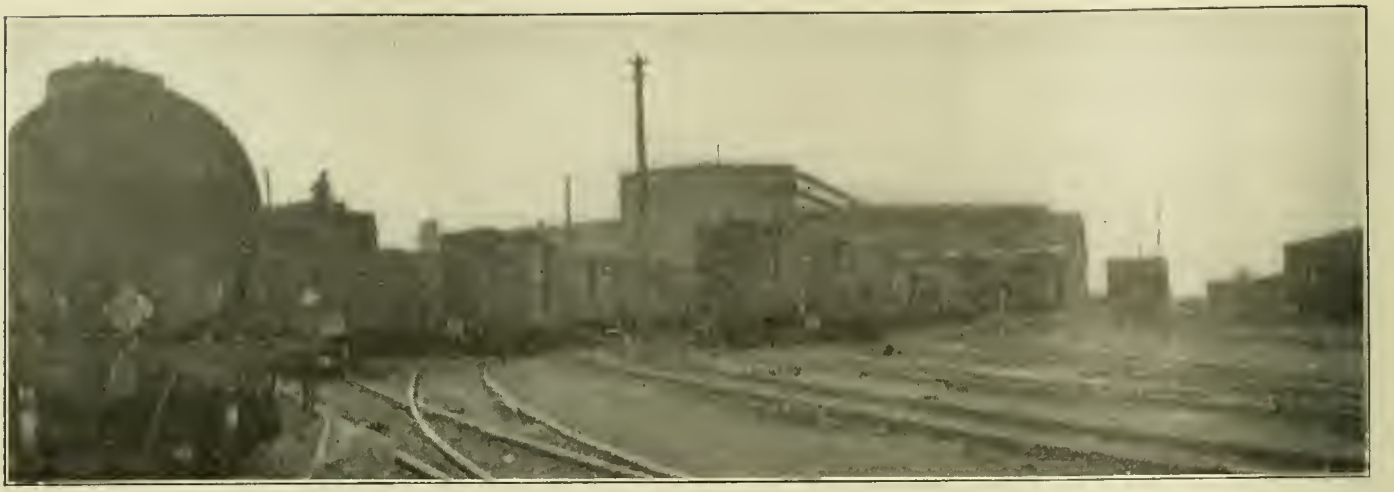
4. That all gear units should be of interchangeable dimensions and of equal travel. That considering the results of the high capacity Miner and National gears of 2½ in. travel, both in new condition and after prolonged service, together with the results from the Westinghouse NA-1 gear which is also of high capacity and of 3 in. travel, it is believed that the maximum travel figure of 2¾ in., as set by the Committee on Standards of the United States Railroad Administration, might well be set as a fixed and required standard travel for all new gears.

5. That from this standpoint of satisfactory operation there is no reason why a draft gear of 2¾ in. travel should not be designed with an ultimate dynamic resistance of 500,000 lb., provided the rate of increase of resistance is uniform throughout the travel of the gear.

6. That no gear should be of a greater capacity at this travel than will close at an impact velocity of 5 M.P.H., with 57½-ton cars, or show a greater drop test capacity than 25,000 ft. lb. Such a gear will close in a 120-ton car at 3½ M.P.H.

7. That the expression, "a draft gear of 150,000 lb. capacity," is erroneous and should not be used; and that the ½-in. rivet shearing test as used to define the above expression should be abandoned in favor of regular 9,000-lb. drop tests, or preferably car-impact tests, until such time as a more convenient test for smoothness of gear action can be developed.

8. That the American Railroad Association should provide itself with a gravity car testing plant of the general character of that used for these tests, whereupon to conduct such draft gear and car construction tests as may be desired.



Scheduling and Routing Systems for Car Shops

Applying Methods Used in Locomotive Work to Freight and Passenger Car Repairs

BY HENRY GARDNER
Mechanical Engineer, Baltimore & Ohio, Baltimore, Md.

MANY forms of scheduling and routing systems have been developed and successfully installed in locomotive repair shops but, to date, very little has been offered as a guide for applying these principles to car repairs, either passenger or freight. Fundamentally, such systems are very similar in outline and application and there is no valid reason for assuming that a system which has greatly benefited a locomotive repair shop will not give equally good results in a car repair shop. The quality of labor employed and the quantity of cars repaired automatically induce systematic operating methods.

The essential features in the installation of scheduling and routing systems in locomotive repair shops may be briefly reviewed as follows:

(1) A supervisor or schedule man and one or more assistants are required, the supervisor to report directly to the general foreman or shop superintendent.

(2) A suitable office should be provided in the shop proper, centrally and conveniently located.

(3) Master schedules, as necessary, covering the principal types of equipment and classes of repairs are prepared.

(4) Shop sheets or order-of-work slips are issued to foremen, conveying the dates assigned by the application of master schedules.

(5) Delay or progress sheets are drawn up giving those in authority details covering causes for delays and time lost on master schedule allowances.

(6) Schedule boards in the supervisor's office, record all information previously issued to foremen on shop sheets. delays are posted on these boards, which finally present a complete record of all scheduling and routing work, together with the output of all departments involved.

Applying the Principles of Scheduling to Car Work

The above fundamentals may now be examined with reference to their applicability to car repairs. The supervisor of car schedules should be a man with practical experience, having preferably served some time, or an apprenticeship, in several car shop departments. He should be of an executive type with initiative and aggressiveness. The clerical type of supervisor is not usually as successful, from the fact that the main objective is co-ordination of all working forces to the common end—*Output.* The supervisor may have one or more assistants, depending upon the size of the plant, and these men can handle all clerical details. In very large shops it is desirable to employ a man carrying the title of production engineer or shop specialist, who would have charge of all scheduling and routing methods in all departments of the plant.

It is important to have the schedule office located in the shop. It may best form a part of the general foreman's office or open into it. Foremen should be free to discuss matters frequently with the schedule supervisor and visit the office to examine their department records as shown on the schedule boards. The schedule supervisor is essentially a shop officer, ranking with and having a common interest with the foremen. Their close co-operation is not only desirable but imperative if the best results are to be obtained. In some shops it may be convenient to consolidate the locomotive and car department schedule offices, but for most efficient operation the car department office should be located in the car shop.

Preparing Master Schedules

Master schedules for locomotive repairs are now pretty generally standardized. About 50 important operations are listed in order of occurrence and a date or day of the month assigned for each. Different classes of repairs require separate schedules, longer or shorter; also different types of equipment may influence the assignment of dates or operations. In general the master schedule is a simple list of operations stated in the order in which the work is to be performed. Master schedules also list the principal items or groups of material and assign dates when such parts are wanted in the several departments of the shop.

It is not difficult to apply master schedules to passenger or freight car repairs. For passenger cars the type and number of car and class of repairs should be noted, also the estimated date on which repairs should be completed, and the number of the schedule which applies. A convenient form of master schedule for passenger car repairs would show the exterior and interior repairs and painting work separately. For example, a 1-A-2 repair would mean Class 1 or "heavy" exterior repairs, Class A or "heavy" paint repairs and Class 2 or "medium" interior repairs. Any convenient combination of numbers and letters will be found useful in assigning correct master schedules to suit the nature of the repairs indicated by a close inspection of the car considered.

Painting work governs passenger car repairs to a large extent and master schedules should be selected only when recommended by the shop foreman. The carpenter work must be finished before paint is applied but the days required for painting operations is the principal consideration when applying a schedule. Painters' work, when applied to heavy car repairs, usually requires so much time that work on other parts such as air brake, truck, electric wiring, heating, fixtures, sash, upholstery, etc., can be made ready during or soon after painting, varnishing, etc. For heavy repairs to a passenger coach, requiring perhaps about 16 days in the shop, the master operation schedule should carry about 15 items for checking the various classes of paint shop work applicable to the inside and outside of the car. Other work, as indicated above, will require about ten items on this schedule. "Constants," as now generally understood and used in locomotive shop practice, are also applied to passenger car master schedules and the shop sheets may be filled out with actual dates for foremen by using a special slide rule, if desired, exactly as is done with locomotive shop schedules.

Methods of Handling Shop Sheets

Shop sheets or order-of-work slips are simply complete master schedules split up, the proper portions being delivered to the departments interested. Shop sheets carry exact dates, or days of the month, in place of the "constants" or constant intervals of time (represented by days) shown on master schedules. These shop sheets are handled exactly as in locomotive practice. In some shops small blackboards are used in place of shop sheets, or information from shop sheets may be copied upon special forms bulletined in the foreman's office. One large passenger car shop has found it good practice to hang a general shop sheet, carrying information for all departments, on the end of the car being repaired. Foremen can then see at a glance in what order their work is scheduled and the status of the repairs may be checked quickly by supervisors and those in higher authority. Sub-departments located some distance from the car repair shop proper should have their order-of-work sheets delivered, since much time would be wasted by men from these departments visiting the car for purpose of learning work assignments from the general shop sheet.

Delay sheets, or progress reports, assume the same form as those already described in numerous published articles outlining systems for locomotive repair shops. What is needed simply is a record showing the number of days each operation or material item is late on the time allowance designated by the standard master schedule. Such delay sheets are preferably issued daily to the foremen of delinquent departments, copies going to the general car foreman, master mechanic or superintendent of shops. Delay sheets must be accurate and immediate if beneficial results are to be obtained. Delays are posted, usually with red ink, on the supervisor's schedule board exactly as in locomotive practice. A general analysis of the recapitulation of delays by departments and schedules, monthly, is of value to those in higher authority when periodical or habitual weaknesses occur. Other important situation statements may be made from data carried on schedule boards as desired. These comparative records assume the form of "delay days per car dispatched," "delay days per department" or "per cent of delay days per department," etc. Such competitive records are not punitive but stimulate effort and furnish correct information for use in adjusting the shop design, equipment or organization.

A successful passenger or freight car schedule system is to a considerable extent dependent upon operations outside of the immediate working organization. Proper switching of cars, layout of tracks and shops all have a bearing upon the schedule plan. Cars entering the shop for repairs should be separated into heavy, medium and light classes and, if possible, segregated on tracks so arranged that a minimum amount of lost motion, either with men or material, is assured. Passenger cars with exteriors finished should be set outside of shop as early as possible to provide shop track space and interiors may be completed when the car is outside and under steam. In large plants gang work on passenger cars is to be recommended, but this organization feature is not emphasized to the extent described later for freight equipment shops.

Scheduling Freight Car Repairs

Proper scheduling and routing of freight equipment is, perhaps, the most difficult problem of all. Freight car repairs not only occur in great numbers, but are of many types and classes. It is only feasible to consider scheduling the heavy repairs, for example those requiring over 20 man-hours, and in any event the items scheduled must be boiled down to the least number possible and still be of sufficient importance to justify the scheduling and routing work. The supervisor and his office will generally conform to what has already been said with relation to passenger cars. In most cases one office for the entire car department will be found adaptable.

Master schedules for repairing freight equipment, because of faster deliveries, must carry smaller intervals of time than for locomotives and passenger cars. "Days" and "hours" must be substituted for "days" only as heretofore. A master schedule might be made to cover a heavy repair requiring, say, 40 man-hours, or one man five days. Operation items must be cut down to ten or fifteen important work classes such as "Car in Shop," "Stripped," "Sills O. K.," "Draft Rigging O. K.," etc., to "Car Painted" and "Out of Shop." Perhaps a date for the work of each special gang would be sufficient. It is not now considered necessary to make out master schedules for individual cars, and the small scheduling force could not possibly take care of a shop delivering 300 heavy freight car repairs a month if each car were assigned a special schedule. Schedules should preferably be made to cover groups of cars and all cars in a group should require repairs of such character that one general schedule is found sufficient.

Routing Material

Material for repairs may be handled by a separate system controlled by the schedule supervisor. One large car repair shop has a material routing plan which operates as follows. An assistant foreman in the main repair shop inspects entering cars and lists all material needed for making repairs. This list is written up on a special form or order which is taken up by supply men at frequent intervals daily. The material routing clerk receives copies of these orders and periodically checks all departments, visited by supply men and also checks material arriving at destination in the main repair shop. Records of delays by departments and delays for which supply men are responsible are tabulated in the clerk's office and subsequently forwarded to the general foreman or shop superintendent for their information and action.

Group Schedules for Freight Cars

It may be well to refer further to the group idea for freight car schedules in contradistinction to the individual unit schedule applied to locomotives and passenger cars.

Incoming cars may be switched to tracks so arranged that similar classes of heavy repairs are segregated as far as practically possible. For example, a group of ten box cars which require from 40 to 80 man-hours each for complete repairs are located on track number 1 in the shop. A master schedule may be made up by the supervisor in such manner that this track of ten cars may be switched completed on the same day, or two consecutive days. Although these cars are estimated to require repairs extending over periods of five to ten days for one man, yet they will all probably go out in three or four days when all gangs work continuously on them. The master schedule for this ten-car group would then be made up for the average time allowed, say three and one-half days, and the major items of work scheduled in proper sequence in the same manner as for any other class of equipment, except that time allowances are given in hours. It may be found desirable to bulletin a general or track shop sheet in some convenient location where all foremen can keep posted regarding the schedule allowances for their gangs. Duplicate sheets may be given foremen of departments whose headquarters are some distance from the main shop.

Moving Gangs vs. Moving Cars

Daily delay sheets should be issued covering each track or group of cars exactly as done for passenger car units described previously. The most successful freight car scheduling is obviously dependent upon large operations, sufficient material and supplies, and a complete organization which will enable men to be highly classified into special gangs. One large railroad has developed the gang plan as follows. Incoming cars are switched to several adjacent tracks, care being used to separate cars by repair and equipment classes as far as possible. Specialized gangs begin work on track number 1, when work is finished they pass to track number 2 and so on to the last track. Each gang is scheduled and checked for the number of hours allowed for doing the work on all of the cars on each track. A delay sheet, for example, might read partially as follows: "Gang number 2, stripping, track number 3, 1 hour late," etc. There should be a stripping gang, sill gang, draft rigging gang, paint and stencil gang, etc., as found best suited to local conditions. Specialized working gangs eliminate dead time and many large car shops have demonstrated that, as in locomotive shop practice, the use of groups of men or gangs always results in increased output with lowered costs. Scheduled shifting gangs will enable the supervision to easily check up their men, locating them on a certain track at a stated time.

Some freight car shops have adopted an opposite plan by having the gangs stationary and moving the cars. Cars are switched to tracks, separated by repair and equipment classes and scheduled in the same general manner as outlined in preceding paragraphs. As fast as one class of work on a car is completed by a gang, it is moved forward to the next gang organized to handle the repairs needed. Objection may be raised that frequently switching or moving cars adds to the expense, but this may be offset to some extent by savings incident to permanently located riveters, forges and other heavy tools and appliances. It is possible that men may wait for work in some cases or for a car movement, thereby losing time which possibly would not develop if the gangs moved and the cars remained stationary. These two plans should be thoroughly tested and data furnished which will definitely state the advantages and disadvantages of each and make positive recommendations for future guidance.

There is no question regarding the advisability of extending practical, up-to-date scheduling and routing methods to passenger and freight car repair shops. Just what form the necessary schedules and sheets will finally assume has not yet been thoroughly worked out and published. It is not difficult to handle the car department situation, but some tracks must eventually be relaid, cars must be more carefully grouped and spotted and more special gangs organized. There is a large field for thought and careful planning when designing new shops to provide proper tracks and facilities which will co-ordinate with production systems or schedules best adapted to maximum output at minimum cost.

On the basis of experience with electric traction on the Norfolk & Western, the American Railway Engineering Association's Committee on Electrification concludes that 44,000 volt current for transmission and 11,000 volt single-phase current for the overhead line are practicable for lines having heavy gradients and heavy traffic, and that probably this system will effect a saving of at least 12 per cent of the total annual expenditure as compared with steam operation.

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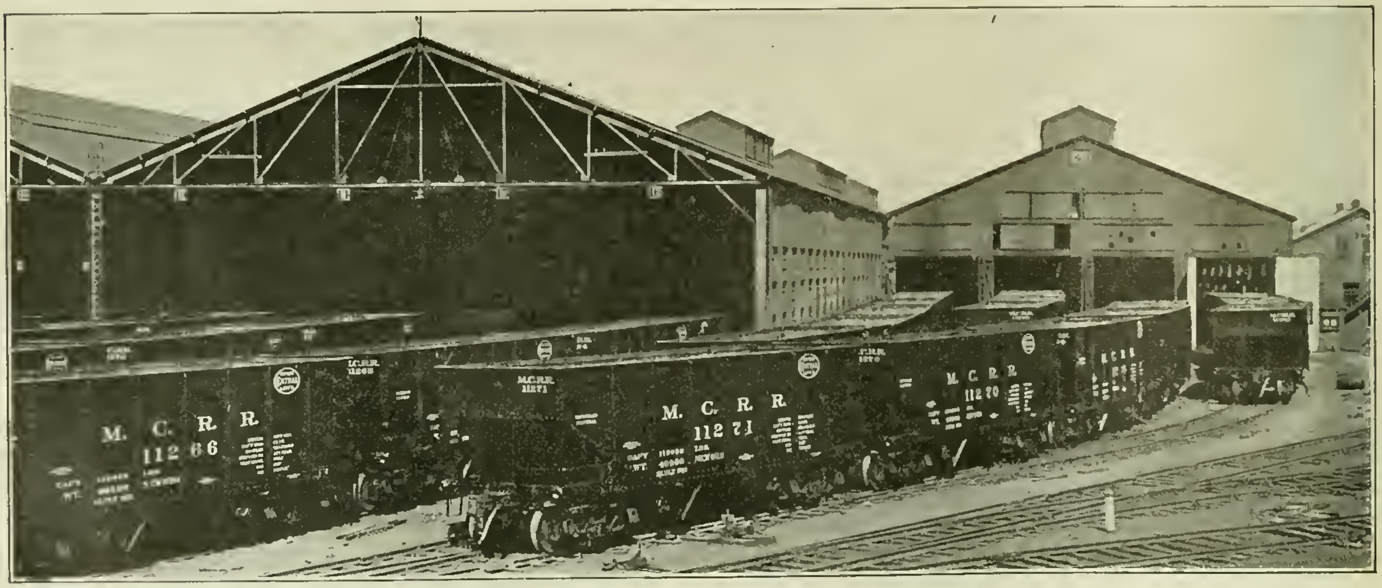

At the McKees Rocks Plant of the Pressed Steel Car Company

Some Failures of Chilled-Iron Car Wheels*

Chemical Specifications Proposed to Improve Service—Importance of Low Percentage of Phosphorus

BY H. J. FORCE
Chemist and Engineer of Tests, Delaware, Lackawanna & Western

THE cast iron wheel has a marvelous history. Approximately 26,000,000 chilled-iron wheels are now in use in the United States and Canada, under freight cars, passenger coaches, refrigerator cars, engine tenders, city street cars, interurban cars and electric locomotives. Eighty to ninety per cent of all the equipment in the United States and Canada is equipped with cast iron wheels. The annual production in the United States is approximately three million wheels, some of which are exported to France, Russia, Italy and other foreign countries. A large proportion of the total production is required for repairs.

It is the object of this paper to point out such recommendations and changes as are thought to be necessary in the chilled-iron wheel. It is well known that during the past few years railway cars have been loaded to greater capacity; heavier equipment has been placed on many lines; many roads are using rails much heavier than a few years ago; roadways are rock ballasted, and are very largely equipped with tie plates. This rigid track construction has placed a greater duty upon the chilled-iron wheel, a condition which it is felt the manufacturers possibly have not realized, for little or no effort has been made to improve the quality of the wheels to meet these severe conditions.

The cast iron wheel is about the only part of railway equipment which is not purchased to a chemical specification; yet it is the most important part of such equipment. The failure or breakage of one wheel in a train almost invariably results in derailment. Such chemical specifications as have been recommended are not generally acceptable both to the manufacturer and the consumer. It is generally conceded that unless an improvement is made in the quality of cast iron wheels, the railway lines will be forced to give careful consideration to the use of steel wheels, with the hope that fewer failures will result in service.

A study of the service condition of cast iron wheels leads to the opinion that this wheel can be greatly improved, and that it will be found to be satisfactory under nearly all equipment. It has been claimed that the ordinary wheel on certain lines is satisfactory. This may be true where such lines do not have any lengthy and heavy grades, but where these grades do exist failures from cast iron wheels are constantly resulting; and as every class of equipment is handled over these lines, it is necessary that the wheels on all lines be made of the best possible composition.

During the year 1920, 42 failures occurred from broken wheels on the lines of the Lackawanna, and with very few exceptions these were on foreign cars. For 1921 14 failures have occurred which caused derailments.

TABLE I—WHEELS WORN OUT IN SERVICE
(All Values in Per Cent)

Mark	Cast	Total carbon	Graphitic carbon	Combined carbon	Phosphorus	Sulphur	Manganese	Silicon
A	9-20-15	3.31	2.32	0.99	0.360	0.154	0.49	0.70
B	6- 2-16	3.53	2.77	0.75	0.308	0.136	0.66	0.73
C	7- 2-13	3.17	2.18	0.98	0.304	0.155	0.55	0.65
D	8-24-12	3.08	2.15	0.93	0.260	0.122	0.43	0.59

Four wheels were selected from a number of wheels which had been worn out and marked A, B, C and D. Table I shows the date each wheel was cast, and gives the composition. It will be noted that in most cases these wheels meet the requirements of the specifications recommended later, although no effort apparently was made to make the wheels to any specification. The table shows the fact that the composition as to phosphorus and sulphur, and especially silicon, is fairly satisfactory. It should also be pointed out that the wheel with the lowest sulphur and lowest phosphorus apparently gave the best service. The higher silicon wheels in all cases showed more wear than lower silicon wheels. On the other hand, it is believed that the combined carbon content, which in one case is as high as 0.99 per cent, is outside the limit for a cast iron wheel which would give the best service.

TABLE II—WHEELS FAILED IN SERVICE
(All Values in Per Cent)

Mark	Cast	Total carbon	Graphitic carbon	Combined carbon	Phosphorus	Sulphur	Manganese	Silicon
1	8-27-17	3.24	2.24	1.01	0.420	0.176	0.57	0.70
2	......	3.36	2.13	1.23	0.430	0.191	0.41	0.82
3	......	3.35	2.46	0.89	0.440	0.200	0.65	1.06
4	4-15-18	3.37	1.87	1.50	0.384	0.182	0.39	0.75
5	5-28-13	3 34	2.19	1.14	0.388	0.199	0.52	0.75
6	3-28-18	3.34	2.10	1.24	0.386	0.146	0.36	0.76
7	6-28-20	3.22	1.91	1.31	0.354	0.193	0.52	0.80
8	8-21-19	3.20	1.99	1.21	0.384	0.261	0.67	0.88
9	3-14-18	3.19	2.24	0.95	0.364	0.171	0.50	0.84
10	3- 9-20	3.34	2.15	1.19	0.428	0.185	0.52	0.69
11	10-13-17	3.19	2.16	1.03	0.408	0.138	0.38	0.70
12	9- 3-19	3 33	2.24	1.08	0.370	0.197	0.60	0.76
13	12-30-18	3.32	2.34	0.98	0.420	0.175	0.79	0.73
14	......	3.12	2.14	0.98	0.420	0.219	0.72	0.93
15	2-17-15	3.32	2.20	1.12	0.400	0.190	0.43	0.68

Table II shows a list of wheels which failed in service and in each case caused a serious derailment. Note here the high combined carbon, high phosphorus and uniformly high sulphur, in some cases low manganese, and in many cases high silicon. Wheels of this composition should not, under any circumstance, be placed in service. It will be noted that some of these wheels gave very little service, and it is safe to say that the wheels were shipped without the knowledge of the manufacturers as to their chemical composition.

Analyses were taken on a number of wheels made on different dates by three different wheel foundaries, the majority being cast in 1920. Foundry B was asked to furnish wheels with not over 0.35 per cent phosphorus, but analysis showed considerable high phosphorus. This was the first attempt of this foundry to make wheels to a chemical specification. The same request was made of foundry A, and in this case all wheels conformed to the specification as to phosphorus. In foundry N effort was then made to have the wheels contain not over 0.32 per cent phosphorus. In every case the wheels conform very closely to the specification, and it is felt that no undue hardship will be imposed upon the wheel makers to have phosphorus not over 0.32 per cent and that a better and safer wheel will in every case be produced.

It is not contended that a chemical requirement will at once eliminate all wheel failures, for it is possible that an occasional wheel will fail in service from inferior composition due possibly to some oversight on the part of a workman in the foundry.

In order to show the necessity for chemical requirements in a specification, attention is called to an analysis of 252 wheels from 28 different foundries that were being removed in our shop in the ordinary routine of operation. No selec-

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*From a paper presented at the annual meeting of the American Society for Testing Materials, June 21-24, 1921.

tion whatever was made; the wheels were taken just as they came into the shop to be removed for the various causes cited below:

Cause of removal	Number of wheels	Average life
Brake burns	21	5 yr. 1 mo.
Cracked plates	61	4 yr. 5 mo.
Seamy rims	31	6 yr. 11 mo.
Worn flanges	56	7 yr. 8 mo.
Worn through chill	4	7 yr. 2 mo.
Shelled out	33	6 yr. 6 mo.
Seamy treads	4	4 yr. 0 mo.
Slid flats	35	3 yr. 4 mo.
Chipped rims	7	8 yr. 1 mo.
Total	252	

The average life of these 252 wheels was 5 years and 5 months. The total percentage of cracked plates in this lot is approximately 24 per cent. Taking this as an average, the total number of wheels removed for cracked plates during a period of twelve months on the Lackawanna would be approximately 8,000.

In our judgment, the cracking of plates is due very largely to inferior chemical composition. Seamy rims and seamy treads are as a rule due to foundry practice, and are usually the result of metal being poured at too low a temperature. It is hardly necessary to call the attention of the manufacturer to the necessity of immediate improvement in both manufacture and composition of cast iron wheels.

It is recommended that the question of drop test and thermal test be carefully investigated. We believe these tests should be made as severe as possible, so that none but good wheels may be shipped.

The Association of Manufacturers of Chilled Car Wheels has given assurance that the manufacturers are anxious to lend all possible assistance in the production of a first-class wheel. The following specification is therefore recommended, covering all weights of chilled-iron wheels:

SPECIFICATION A

	Per cent
Total carbon	3.00 to 3.65
Combined carbon	0.45 to 0.85
Manganese	0.50 to 0.75
Phosphorus	Not over 0.32
Sulphur	Not over 0.17
Silicon	0.45 to 0.75

It is felt that the heavier wheels which are now being recommended will have a further tendency to reduce failures.

It is recommended that special consideration be given to a wheel which contains a small percentage of nickel and chromium, as indicated in specification B. Wherever wheels of this composition have been placed in service, the results have been highly satisfactory; and the wheels should be especially suitable for the heavier equipment. The increased cost of these special wheels will run from seven to ten per cent.

SPECIFICATION B

	Per cent
Total carbon	3.20 to 3.75
Combined carbon	0.40 to 0.80
Manganese	0.45 to 0.65
Phosphorus	Not over 0.15
Sulphur	Not over 0.17
Silicon	0.45 to 0.70
Chromium	0.10 to 0.25
Nickel	0.10 to 0.20

Every wheel maker understands that while his metal may be of the proper composition, an inferior wheel can be produced due to faulty foundry practice, such as allowing wheels to be cold when pitting, or maintaining pits in improper condition. However, if the foundry practice is correct and the wheels are of the proper chemical composition, there is every reason to believe that a good, safe, cast iron wheel can be produced. The drop and thermal tests, together with an examination of the fracture and depth of chill, usually reveal the method of foundry operation.

The majority of the failures of wheels previously cited occurred near the bottom of long, heavy grades, probably due to the elevated temperatures which the wheels attained. In nearly all cases failure occurred by rupture of the plate, and it is important, therefore, that the composition be controlled so that as much strength as possible may be obtained and the wheel enabled to withstand the elevated temperatures developed on all heavy grades.

With the increase in weight of the wheel, the heavier plates and thicker flanges, there is good reason to believe that the cast iron wheel will continue to serve the railways of the United States for many years to come.

Standardizing Car Equipment

The National Association of Owners of Railroad Securities recently appointed a Board of Economics and Engineering to study the methods of effecting economies in the operation of the railroads. L. B. Stillwell, consulting engineer and one of the members of the board, in the hearings before the Senate Committee, presented the report of the board on the subject of rolling stock. Mr. Stillwell advocated having cars owned and maintained by an equipment corporation with a view to effecting standardization, improvements in design, construction and maintenance, and the stabilizing of orders and maintenance work. An abstract of the statements submitted by Mr. Stillwell is given below.

Among the objectives toward which the board has planned to direct its investigation and efforts, the following may be mentioned: (a) Further standardization of freight and passenger cars. (b) Stabilizing of orders for new equipment and for replacement and repairs. (c) Establishment of a system of periodic repairs of freight cars. (d) Strengthening or retirement of weak cars, or their restriction to local service on home lines.

FREIGHT CARS

Standardization of freight cars as affecting interchangeability has already been accomplished in large degree. The railroads are using, however, even in identical service, cars differing materially in strength, weight, capacity and durability.

From the experience gained in operating these cars, a limited number of standard types and sizes should be selected or developed for interchange service and thereafter adhered to, except in special cases where the reasons for deviation may unquestionably be controlling.

Standardization should not preclude development and improvement in design and material, but should secure interchangeability as regards component parts, and it should define minimum limits of strength of essential parts. This can be done without sacrificing the advantages of competition between manufacturers in the development and sale of their specialties, as the establishment of minimum limits in no way precludes progress by improvement of material or design within the dimension limits fixed by the interchangeability rule.

In selecting or developing standard cars, life and weight are of the greatest economic importance. For illustration, if the country has 2,500,000 freight cars and the average life is 20 years, 125,000 cars per annum must be purchased for replacement.

If the average life could be increased to 30 years, by improved design and systematic maintenance, the same result would be accomplished by purchasing 83,000 cars per annum. The difference, 42,000 cars, at present prices would cost about $100,000,000.

Broadly speaking, durability (life) points toward an increase of weight in design, but weight does not necessarily mean strength, and it is obvious that the interests of the railroads call for a complete study and action which will secure durability without excessive weight.

STABILIZING MAINTENANCE

A condition which results in a very great increase in cost of railroad operation exists in present repair practice, each road being supposed to repair all cars which develop the need of repairs while on its lines.

Obviously the best interests of the railway industry as a whole require that in slack periods when cars are plenty such cars should be put into good condition in order that they may be available when heavy traffic returns. Under present conditions, repairs are often postponed because of lack of available funds.

Relative Economy of Electric, Oil, Gas and Coal-Fired Furnaces*

BY T. F. BAILY†

Rapid elimination of natural gas as an industrial fuel and the rapid increase in the price of fuel oil, coupled with the statement of the United States Geological Survey that shortly it will not be available as an industrial heating medium, have brought the attention of the public generally to electric furnaces as one ultimate type of equipment that will combine not only accuracy of treatment to a degree which was never possible in fuel fired furnaces, but also reliability from the standpoint of supply of heat, as electricity has now become the most common of all commodities. It is true that there is a considerable thermal loss in the transformation of fuel to electric energy, nevertheless, the modern power plant is able to use the lowest grade of fuel; while the fuel used in industrial furnaces generally has been more expensive, as well as more difficult to obtain, as is evidenced by the gas and oil situation today.

From the standpoint of fuel conservation, it is of interest to note that even when taking into consideration the thermal efficiency of a modern power plant and distribution system of only 15 per cent, and an electric furnace efficiency of an average of 60 per cent, the net thermal efficiency for the entire cycle would be at least 9 per cent. On the other hand, assuming the same grade of fuel could be used conveniently in small industrial furnaces, which are now mostly fired by oil or gas, the efficiency probably would not run over 5 per cent, and probably it would require a higher grade of coal. Besides this, it would necessitate a modified design of furnace with a large combustion chamber. This would require a much larger floor space and would mean a complete new plant arrangement in most present installations. On the other hand, the electric furnace requires little more space than the present type of oil or gas-fired combustion furnace.

From a cost standpoint, it is difficult to make an accurate comparison, because of the wide variation in efficiency of the various fuel-fired furnaces; but taking as a basis, in the case of oil for heat treating operations, a consumption of 30 gallons of oil per ton of product, and with oil at 15 cents per gallon, which is the prevailing price at the present writing, the cost would be $4.50 per ton for fuel only.

With natural gas-fired furnaces, it is doubtful whether an efficiency of better than 6,000 cu. ft. of natural gas per ton of product can be maintained, and at a price of 50 cents per 1,000 cu. ft. the cost would be $3 per ton for fuel only. An electric furnace of the same capacity, which is taken as 1,000 pounds per hour, would consume not to exceed 300 kilowatt hours per ton of material heated, with an average fuel cost of 1¼ cents per kilowatt, which would bring the cost to $3.75 per ton for fuel only.

Thus it is to be noted that under average conditions on small sized units, which are the most common types found in the heat treating industry, there is not a great variation in fuel cost; and, after all, this is of minor consideration when compared with accuracy of treatment, in which field the electric furnace is preeminently fitted to produce the highest quality of material. This is especially true of the electric furnace when coupled with automatic control devices, either of the time element or pyrometer control type.

In the larger capacity furnaces handling several tons per hour, direct coal-fired or producer gas fired furnaces, which obtain their gas from soft coal, show much better economies; but in similar capacities, electric furnaces also show better economies. When taking into consideration the recuperative car-type furnace, the current consumption will fall when annealing larger tonnages of steel, to as low as 120 kilowatt hours per ton. This with current at one cent per kilowatt hour, the probable rate under such conditions would be $1.20 per ton for fuel, as compared with coal-fired furnaces with coal at $4.80 per ton. This would mean that from a fuel standpoint alone the producer gas-fired furnace would have to have a consumption of not to exceed 500 lb. of coal per ton of metal heated. Besides, the difficulty of obtaining the desired grade of coal to operate well in the producers; the additional labor cost for handling both fuel and ashes from the producer; and the much larger space required for both the producer and gas-fired furnace are disadvantages.

Foremanship a Profession

The art of successfully managing men surely requires as much tact and knowledge as is required by the average professional man. True, we are only just coming to a full realization of this, yet how little attention is given to the training of foremen and how little time the average foreman is able to give to study and research.

Are the managements not making a serious mistake in allowing the foremen to go ahead with blinders on, their views being restricted to narrow limits which do not include a large conception of the latent possibilities of the human element or the principles underlying efficient production?

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*A paper presented by title at the Philadelphia convention of the American Society for Steel Treating.

†President, Electric Furnace Company, Alliance, Ohio.

From a labor standpoint the electric furnace requires the least attention. In some of the larger units used in heat treating, consisting of two furnaces and an automatic quench between, two men on the combined unit will handle as much as three tons of material per hour; while in nonautomatic plain hearth-type fuel-fired furnaces several times as many men would be required.

Still more important, it would be impossible to control in this hearth-type fuel-fired furnace, the heating cycle and the quenching conditions of the heat treating operation with anything like the accuracy obtained by the automatic electric equipment. In some operations, such as the annealing of high carbon high chromium steel, wherein a definite cooling cycle is required, the electric furnace offers substantially the only certain means of controlling this cooling cycle.

The comparison of the three types of furnaces may be briefly summed up in the statement that while no great difference exists in the actual fuel cost between the three, the electric furnace at the present time is the one that seems most certain of a continued and uninterrupted supply of fuel. In numerous cases the actual fuel cost may be higher with the electric furnace than by oil or gas; but for the accuracy of treatment and from a standpoint of cost per ton of material which actually meets the specified requirements, the electric furnace probably will be cheaper than any of the other types, and can be depended upon absolutely from a production standpoint.

A Surgical Operation Performed on a Locomotive Valve Port*

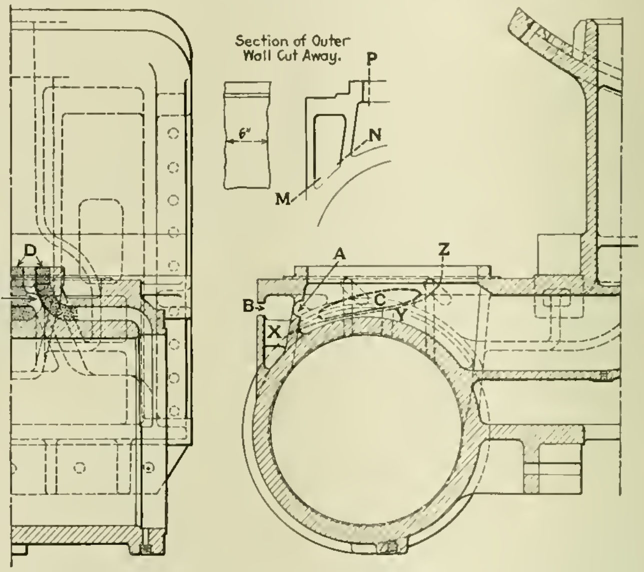
BY M. R. FEELEY
General Foreman, Delaware, Lackawanna & Western, Hoboken, N. J.

About fifteen months ago a slide valve locomotive operating on the Delaware, Lackawanna & Western out of Hoboken, N. J., was reported by enginemen as leaking steam under the cylinder jacket on the left side. Opening the steam chest and removing the main valve disclosed a cavity *A* in the cylinder wall which had broken through at this point. In the first attempt to repair the break a hole *B* was drilled in the outer cylinder wall large enough to allow for drilling, tapping and inserting a plug at *A*.

The locomotive was returned to service but in a short time was again reported as having a bad blow, this time apparently in the left cylinder packing. At the first opportunity the locomotive was returned to the roundhouse, the usual tests being made to locate the blow. Both the cylinder packing, valve seat and valve packing strips seemed to be all right and difficulty was experienced in finding the trouble until a light inserted in the exhaust passage flashed through into the steam port. This indicated plainly that the bridge between the two ports was defective but due to its position, the defect was not only difficult to see, but apparently impossible to repair by welding. The location of the defect is shown at *C* in both the side and end views of the cylinder. A careful inspection of the bridge showed that it was not in reality cracked but that the entire enclosed section marked *C* was thin and had broken through in one point. The cause of this thin bridge and also of the cavity at *A* was evidently a shifting of the core in originally casting the cylinder. As shown, the thin section extended over about two-thirds of the length of the bridge.

The difficulty of repairing this cylinder defect by welding was realized but in view of the great need for motive power at that time and also to save as much money as possible on the job, it was decided to see what could be done by welding, the following method being used. A six-inch section of the outer cylinder wall was cut out along the lines *M N P*. In addition a section of the bridge was chipped out along the lines *X Y Z*, in other words, down to a point where the bridge was of a normal thickness. The passages to the exhaust base and steam pipe were plugged and fireclay carefully packed in as shown at *D*, leaving a space where the original bridge had been. In order to secure a smooth job, the surface of the fireclay was covered with plastic carbon.

The next operation before attempting the actual work of welding was to pre-heat the cylinder carefully and thoroughly. This was done in the usual manner by building up a fire brick furnace and burning charcoal under forced draft. The entire cylinder was covered top and bottom and when the required temperature had been reached (preheating took about six hours) a few bricks were removed from the top of the valve seat leaving just sufficient space to get a torch down to the broken bridge. Two men using No. 15 tip oxy-acetylene torches were employed on the job, part of the time simultaneously and at other times relieving each other. Continuous use of the torches in a short time brought the base of the cast iron bridge to a plastic and finally a molten state. Small broken pieces of cast iron cylinder packing were then dropped into the space left for the bridge where they melted and became thoroughly mixed with the other iron, gradually building up the bridge to its original height. In order to secure a good wearing surface the last half-inch of the bridge was built up using special Norway cast iron welding rods. As the bridge was built up, the outer wall was also built up.



Side and End Views Showing Location of Cylinder Defects

The section of the outer wall previously removed was then fitted back in place and welded, thereby completing the welding operations. After all welding was finished, the cylinder having been maintained at a uniformly high temperature throughout, the cylinder was allowed to remain until the following morning without removing the fire brick furnace. The charcoal gradually burned out and by morning the furnace and cylinder were cool. This precaution was necessary in order to reduce internal strains to a minumum. The valve seat was re-faced, the main valve, steam chest and cover being applied and the motion work connected up. The engine was then returned to service and in the past fifteen months has given no trouble from this welding job.

In a discussion following Mr. Feeley's talk, the fact was brought out that this welding repair job saved time and considerable money over what it would have cost to apply a new cylinder. About 3½ days were required for making the repair and the cost was approximately $65 for labor and material.

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*Abstract of an illustrated talk before the Metropolitan section of the American Welding Company, April 17, 1921.

Reclamation Work on the Virginian

Knowledge of Effect of Heat on Material Is Essential for Proper Results in Reclaiming by Welding

BY F. S. TINDER
Material Inspector, Virginian Railway, Princeton, W. Va.

ALTHOUGH great progress has been made in reclaiming railroad material, reclamation is yet in its infancy. Reclaiming scrap and second-hand material by the use of autogenous welding is a scientific mechanical proposition and there is no longer any question of the results of this work from an efficient or economical standpoint where proper methods are used intelligently.

The man supervising reclamation work should have a knowledge of metals to be able to determine the physical condition of castings or forgings to be welded and what methods should be used. He should know the effect of various degrees of heat on the quality of different metals. He should also be acquainted with railroad equipment that he may know what stress and strains the parts must stand. In short, there is no department of railroad work where a knowledge of both theory and practice is more essential. The lack of appreciation of these facts has caused a large amount of inferior work to be done and the various methods of autogenous welding to be discredited.

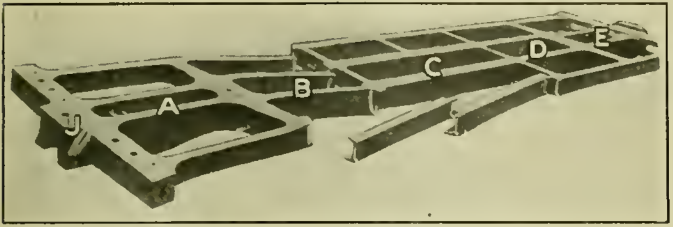


Fig. 1—Tender Frame of Mallet Locomotive as Received at Reclamation Yard

Restriction has been placed on welding certain parts for locomotives and cars by the American Railway Association; parts that could be successfully welded if the art of welding were generally understood. The importance of economy on railroads is now so great that railroad officers recognize the reclamation department as an important means to accomplish that end. This article is intended to tell of some of the work being done in the Virginian reclamation department at Princeton, W. Va.

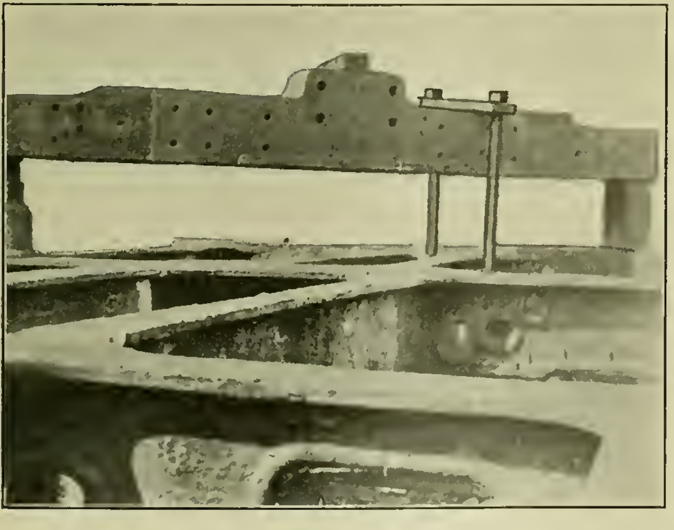


Fig. 2—Use of Cast Steel Bumper as Jacking Beam

Wrecked Cast Steel Tender Frame

Fig. 1 shows the frame of one of the Virginian's largest Mallet locomotives as it was received at the reclamation yard. In addition to being broken as shown, each section was badly twisted, varying with the top surface of the frame from 2 in. to 4½ in. Sections *A*, *C*, *D* and *E* were straightened separately, an old cast steel bumper sill being used as a jacking beam (Fig. 2). Longitudinal members were all heated at the twisted point with an oil burner and each section jacked straight and in line with the other. The ends of broken members in section *B* were heated and straightened by means of clamps and jacks. The end sill *J* was heated and drawn back in place in a similar manner. After all sections were straightened, each broken part was placed in line, leveled, and the parts to be welded prepared by cutting each side of the break to an angle of about 45 deg. with a cutting torch. The parts were preheated and kept hot with a charcoal fire while making welds. The two large center members were first welded, and to prevent stresses and strains being set up in any part of the frame, care was taken to have the proper amount of expansion in these two center members. Trams were used on each member before and after the welds were made and the amount of expansion and contraction carefully noted. This was so well taken care of that there was less than 3/32 in. variation in any part of the job. All welds were reheated and annealed after being completed on account of the size of the frame (8 ft. 6 in. wide by 36 ft. long, weight 10 tons). All welds were made by the oxy-acetylene process. Fig. 3 shows the frame completed. Following is an itemized list showing the actual cost to reclaim with the comparative cost of a new frame:

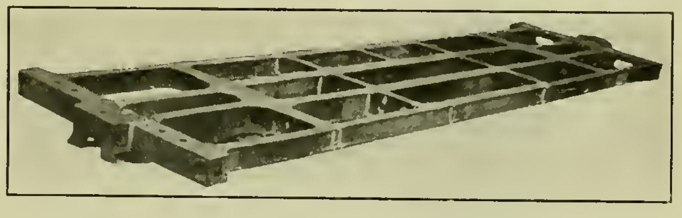


Fig. 3—Large Tender Frame as Reclaimed by Welding

Labor	$305.56
Oxweld welding rods	43.35
Charcoal	11.90
Headlight oil for heating	36.22
Oxygen	55.79
Acetylene	27.14
Total cost	$479.96
Estimated cost of new frame, including freight	$1,600.00
Cost to reclaim frame	479.96
Amount saved	$1.120.04

Reclaiming Car Couplers

Welding car couplers perhaps is the most important work being done at this plant from a standpoint of economy. The cost to weld couplers is not more than one-fifth of the cost new. There are now about 3,000 welded couplers in service and the percentage of these that have failed on account of inferior welds is less than one per cent. Aside from trained welders, much of our success is due to heat treating. All couplers are preheated in an oil furnace, welded while hot, reheated to a cherry red and buried in dry sand to cool slowly. Fig. 4 shows a typical example of coupler reclamation. The record that has been made in this work on the Virginian is of special significance on account of the heavy trains handled. Car couplers with bent shanks and guard arms are reclaimed by heating in an oil furnace and straightened on an air press, which is a home-made machine and has a working pressure of about 50 tons. This machine is also used for straightening channel and angle iron, round and flat bar iron and various other distorted material of different kinds.

Miscellaneous Items

Locomotive piston bull rings are being reclaimed by building up worn parts, using Oxweld manganese bronze welding rods. This work results in a great saving, both in time and labor, as well as material. Various tests have been made which show that the bronze thus applied outlasts the original metal and also prolongs the life of the cylinders. There is no limit to the number of times pistons can be reclaimed in this manner.

Scrap rail frogs and switch points are being successfully reclaimed by building up worn parts with No. 2 Oxweld welding rods. When this metal is applied with a carbonizing flame properly controlled, it gives better service than the original metal. A number of these welded switch points and frogs are in use on the Virginian and are giving very satisfactory results.

Locomotive cylinders, throttle boxes and valves, air pump cylinders, brake cylinders and reservoirs, steam pipes, truck side frames, truck bolsters and other miscellaneous parts of locomotives and cars are being successfully repaired by the oxy-acetylene process.

Fig. 4—Typical Example of Coupler Reclaimed by Welding

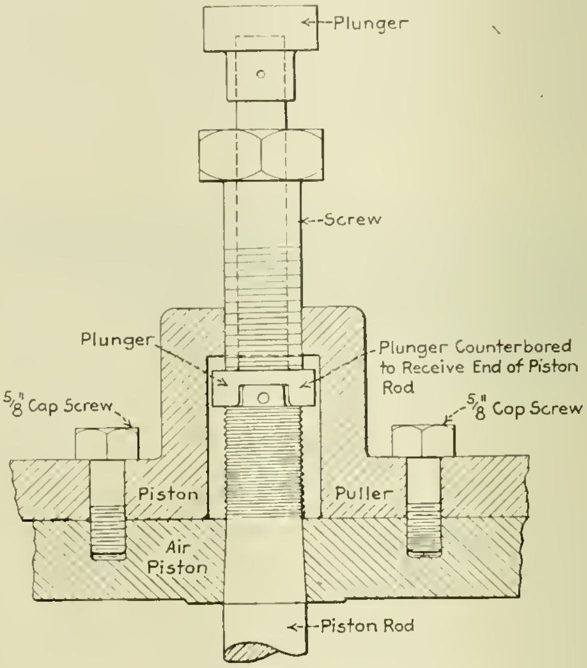
There are many other things in process of reclamation at this plant which it is practically impossible to enumerate. Brake beams, brake rods and levers, globe and angle valves, maintenance of way tools such as tamping picks, clay picks, spike mauls, claw and lining bars are being repaired. Many odd jobs are brought to the reclamation plant that in themselves do not mean a great saving, but by being prepared to do such work immediately it is often possible to repair and return to service equipment which otherwise would be replaced only after a long delay. In addition to actual work, the general influence towards economy exercised by the reclamation department is of great value.

Device for Removing Air Compressor Pistons

BY J. H. HAHN

Assistant Machine Shop Foreman, Norfolk & Western, Portsmouth, Ohio

The illustration shows a useful device for removing air pistons from the rods of Westinghouse air compressors of all sizes. The strap is made of a piece of 2¼ in. stock shaped as indicated and drilled and tapped to receive the 1¼ in. hollow screw, which is threaded 10 threads to the inch. The strap is also counterbored to receive the plunger and piston rod end. The upper part of the plunger is detachable, being fixed in place by drilling and inserting a ⅛ in. pin as shown.



Westinghouse Air Compressor Piston Puller

To remove a piston from the rod, the piston head remover is attached by the use of two ⅝ in. cap. screws in 11/16 in. holes. The screw is tightened down as much as possible with a wrench of proper length, using the customary method of preventing the piston and entire arrangement from turning when the screw is being tightened. After the screw has been tightened sufficiently, a light sledge hammer blow on the plunger will loosen the piston, when it can be removed from the rod. There is no damage to the end of the rods, as is the case when they are loosened by direct blows of a sledge hammer.

The illustration shows the piston head remover as it was used on a Westinghouse 8½ in. cross compound air pump. All pistons in the air ends of Westinghouse compressors, however, have been drilled and tapped to receive two ⅝ in. cap screws, 5½ in. on centers, so this device is readily applicable to all sizes of compressors.

Class I railroads carried 2,249,567,625 tons of freight in 1920. Coal and other products of the mines accounted for more than 1,200,000,000 tons, or 53.6 per cent; grain and agricultural products 220,000,000 tons, or 9.78 per cent; lumber and forest products 197,000,000 tons, or 8.74 per cent; meat and animal products nearly 45,000,000 tons, or 1.99 per cent; manufactured and miscellaneous articles 21.91 per cent, or about 493,000,000 tons. The balance, some 90,000,000 tons, or 3.98 per cent, was the total of the "less-than-car-load" shipments.

Manufacturing Standard Locomotive Repair Parts

A Method of Standardizing and Manufacturing Locomotive Repair Parts in Central Production Shops

BY M. H. WILLIAMS

The great importance of centralized production shops in manufacturing duplicate locomotive parts at reduced expense is becoming recognized more and more by forward looking railroad men. Not only is there a saving in the cost of manufacture, but both locomotives and cars are handled more promptly through shops and terminals due to the ready availability of semi-finished parts. This is the second installment of an article begun on page 451 of the July Railway Mechanical Engineer, *describing the standardization and manufacture of locomotive parts. Taken in its entirety, the article is worthy of the most careful study.*

Standardized Thread Sizes

The products of the central production shop will naturally find their way into practically all shops and engine houses on the system and be made use of as occasion demands. As a result, a nut tapped today may be used on a crosshead or similar article that was made several months previously. Unless the nuts and threaded portions fit properly there is liable to be trouble and complaints, therefore interchangeability of threads is an important feature not only for the good of the road but also for the good name of the central production shop, and hence becomes a problem for this department to solve. Standard thread sizes and limits are now well established for the regular U. S. threads such as apply to the regular bolts and nuts for which standard and limit gages may be obtained to practically any degree of refinement desired.

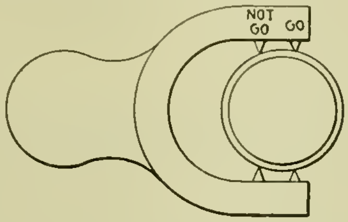


Fig. 8—A Point Thread Gage for Rapid Inspection

Various forms of threads are made use of such as the V, U. S. S., Whitworth, etc. It is not proposed to go into a discussion of the merits of each of these, but it may be said that the U. S. S. or U. S. F. is now becoming generally used for all locomotive work. The U. S. F. thread has the advantage that it can readily be cut by dies and measured by gages and thread micrometers and is therefore to be recommended for the articles made in central shops.

Various degrees of lost motion, or more properly speaking limits between the sizes of bolts and nuts have been recommended for threads used in the different trades. On account of rust and dirt which unavoidably accompanies locomotives it is not generally considered good practice to set these limits as close as is the common practice with machine tool builders or similar lines of product. Generally speaking for threads between ½ in. and 1½ in., if the bolt is between the theoretical size and 0.004 in. minus and the nut between theoretical size and 0.004 in. plus, all requirements will be met for the general run of work. The exception is in the case of boiler fittings where a steam tight joint is required. The two extremes mentioned if placed together will result in a loose nut. However, extremes rarely meet and to adopt the limits mentioned will be following a practice that has been well tried out for locomotive repair work and parts such as are generally made in central shops.

In order that there shall be no question as to the sizes for both the male and female threads, standards and limits should be determined to govern every thread that the central shop is called upon to produce. This in actual practice will be found comparatively simple. When the outside diameter is known it is only necessary to set the pitch diameter to agree with the outside diameter. Tables for the pitch diameter may be found in Brown & Sharpe and other catalogues giving all necessary information on this subject. As an illustration, reference to a catalogue shows that the pitch diameter for 12 thd. U. S. F. is 0.0541 in. smaller than the outside diameter; or a 1-in. staybolt with 12 threads per in. should have a pitch diameter 0.0541 in. less than 1 in. This equals 0.9459 in. or in round figures 0.946 in. Pitch diameters may readily be measured with standard thread micrometers.

On account of the large number of threaded parts that the central shop is called on to produce, it is necessary that gages used for inspection of these parts be simple in construction and require the minimum amount of time when testing each male or female thread. For quick inspection of the male thread it is doubtful whether any gage answers the requirements for minimum time and accuracy as well as the point gage shown in Fig. 8. This is a Go and Not Go gage, the two front points being set to go over a thread that is not too large and the second pair not to go over a thread that is not too small. By the use of this simple gage the pieces may be inspected practically as fast as they can be picked up and laid down, with the result that a larger proportion of pieces will be tested than would be the case under conditions where a cumbersome or unhandy gage is used. For setting the two pairs of limiting points a master male gage is used, the work gages being frequently checked with these master gages.

For checking female threads, limit gages as shown in Fig. 9 are used. The smaller end that is marked Go should readily screw into the nuts and the opposite or larger end marked Not Go should not turn into the nut. Where a large number of nuts are tapped with a single tap it is only necessary to test about one nut out of every 100. Where these two forms of gages are used a great improvement has always been noticed in the fitting of bolt and nut threads.

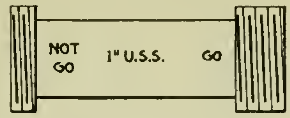


Fig. 9—Limit Female Thread Gage

Staybolts and Boiler Fittings

Staybolts, crown bolts and many fittings used on boilers can be manufactured cheaply in the central production shop for distribution to other points. In order that these parts shall fit properly it is essential that they be threaded to standard sizes subject to reasonable tolerances. Where this practice is followed and taps of correct diameters are used, trouble and complaints from improper fitting will be reduced to a minimum.

In addition to possible errors that may exist in the articles manufactured in the central shop there is also the question of errors in the taps and wear of the same that must be considered. In other words, the standards and limits determined upon must include both the articles manufactured and the taps.

It was the practice a few years ago to make boiler threads of the sharp V form. However, it was found impossible to cut this form theoretically correct in every day shop practice and there was a lack of uniformity of sizes. One shop had one size, the next another and so on. On account of the difficulties encountered the U. S. F. thread is replacing the V form in a number of railway shops with a few places where the Whitworth form is preferred. All things considered, the U. S. F. is to be preferred especially by the central shop on account of being a well established thread which is easy to calculate and measure. The question of thread form may be somewhat foreign to the immediate subject and is mentioned to call attention to the necessity of establishing an easily measured and workable standard that should be used over the entire system.

Having determined upon the form, it is next necessary to set standards and limits for the pitch diameters of the threads. The maximum pitch diameter for U. S. F. should be the theoretical size for each nominal size of bolt as shown in Table I. The question of minimum size is open to argument. If this limit is too close the cost of threading will be excessive. If too much latitude is allowed, the bolts may fit more loosely in the boiler than is considered good practice. Experience has shown that if the minimum pitch diameter is 0.004 in. less than the maximum a happy medium will result and this is to be recommended for all radial staybolts, or all cases where the bolts are riveted or held by nuts. In some cases, as for instance the button ends of crown bolts, the threads are cut from theoretical size to plus 0.004 in. in order that they shall screw tightly and form a steam tight joint.

Table 1—Maximum and Minimum Pitch Diameters, 12 Threads, U. S. F.

Bolt Diameter	Maximum	Minimum
⅞ in.	.821 in.	.817 in.
15/16 in.	.883 in.	.879 in.
1 in.	.946 in.	.942 in.
1 1/16 in.	1.008 in.	1.004 in.
1 1/8 in.	1.071 in.	1.067 in.
1 3/16 in.	1.133 in.	1.129 in.
1 ¼ in.	1.196 in.	1.192 in.

In order to insure staybolts coming within the limits of thread sizes each operator of threading machines should be provided with limit gages as shown in Fig. 8 in order that the pitch diameter may be frequently tried. This threading should also be checked by inspectors by testing bolts selected at random. The results of this gaging and inspection will be that a high standard of uniformity will be maintained that insures the bolt coming close enough to a uniform size to fit properly in correctly tapped holes without adding to the cost of the threading operation.

While the question of staybolt taps may not come within the province of the central shop, it is a question that this department must keep an eye on in order that the staybolts and other articles supplied shall fit properly. Properly threaded bolts will not fit correctly unless the taps used for the boilers are of the right size. Generally speaking the manufacturers of staybolt taps maintain fairly close sizes and will supply to any degree of accuracy demanded. It is essential that the taps when new be somewhat larger than the theoretical diameter and in many cases they are made from 0.003 in. to 0.005 in. large in order that after tapping the sheets the bolt will readily enter and also to admit of a reasonable amount of wear. In order that the bolts shall not fit too tightly the taps should be discarded when worn down to the theoretical pitch diameter agreeing with the maximum size shown, Fig. 10.

While on the subject of thread sizes, mention will be made of thread micrometers, a necessary requisite of the central production shop and tool room. They should be provided in sizes required for all threaded articles to be manufactured. Without measuring devices of this nature is it difficult to measure or maintain sizes and set the gages to the limits required.

Grinding in Production Shops

Frequent reference has been made to grinding operations. As grinding machines have not been generally installed as a part of the central shop equipment, it may be permissible at this point to dwell on this subject. First considering plain cylindrical grinding, there are a number of surfaces on such articles as crosshead pins, crank pins, valve motion pins, etc., that should be finished to exact gage or micrometer sizes in the central shop owing to the economies that may be effected during quantity production. It has been amply proved that these surfaces can be machined in a more satisfactory manner, to closer limits and in less time by grinding than by any other known method. Another point worthy of consideration is that when blanking out articles they need not be kept to as close limits. As a result coarser feeds or cuts may be taken which increases the output of the automatic machines, turret lathes and other tools and also reduces the number of spoiled pieces.

A large amount of grinding on the parts mentioned is now done with broad faced wheels, as wide as the surface to be finished. When grinding, the wheel is fed directly onto the work without lateral motion. By this method the surfaces are ground to limits called for in from one to three minutes. It will readily be noted that this is much quicker than finishing by filing and emery papering. Longer surfaces must from necessity be ground by traversing the work back and forth in front of the wheel. In order to perform the grinding operations successfully and economically it is essential that large and rugged machines be provided. As a general rule these should not be smaller than the 10 in. by 36 in. size, heavy model.

Internal grinding where suitable machines are used has been found economical. However, in order to obtain the desired results it is necessary, as in the case of the cylindrical grinder, to make use of rugged machines which will remove metal quickly. Therefore the combination machine intended for external and internal use is of little value. The grinder should preferably be of the form known as the internal chucking grinder, having ample belt power and rigidity to drive the grinding wheel to its limit, and also arranged so that the work may be quickly placed in and removed from the chuck with all facilities for rapid handling and grinding. With a machine of this nature, the cost of finishing the bores of bushings is reduced to a point where the advantages of accuracy and interchangeability will much more than offset the extra time consumed by the grinding operation.

In order to obtain data as to the relative cost of finishing by grinding as compared with filing it will be found profitable to visit some of the outside shops that make extended use of grinding machines and compare the time taken in these places and in the home shops. A visit of this nature will generally reveal the fact that practically every cylindrical piece is finished on grinding machines owing partly to the close limits considered necessary and to the fact that grinding is the cheaper way to produce smooth and true surfaces. Much could be written on grinding operations in central production shops, but a visit of this nature will be more convincing than many books.

Reducing Maintenance Cost of Valve Chamber Bushings and Packing

BY FRANK ROBERTS

It has been the practice on an eastern road to bore steam chest bushings, when applied new, 12 in. on passenger and 14 in. on freight locomotives. After a time, service develops the usual wear, the bushings becoming out of round, scored, shouldered or otherwise defective, making reboring necessary. The practice is to keep both piston valves the same diameter. This makes it necessary to bore both sides whenever any one of the four bushings has a condition that will produce leakage past packing rings. The life of a steam chest bushing has previously been limited to three service periods, each being 3/32 in. above the last; first 12 in., second 12 3/32 in. and third 12 3/16 in. The packing rings were of necessity only good until bushings were rebored, when it became necessary to replace them with a new set 3/32 in. larger in diameter. The old ones were invariably scrapped.

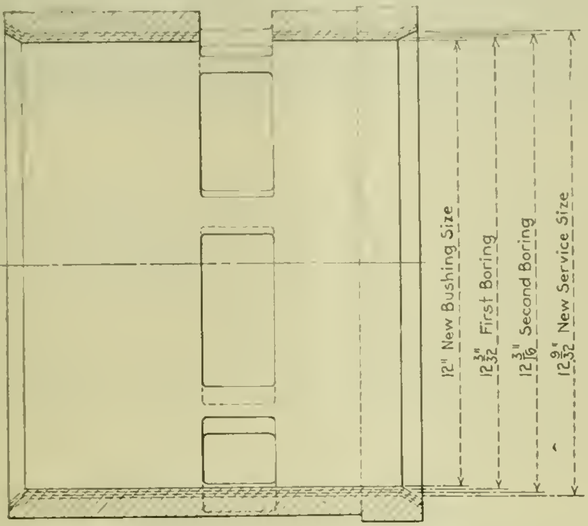


Fig. 1—An Additional Boring Is Obtained from this Bushing

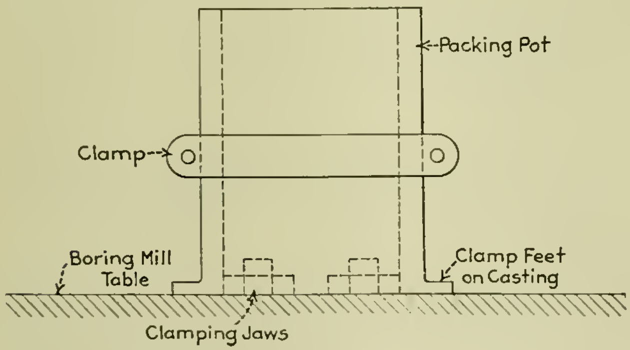


Fig. 2—Cut Packing Pot Closed by Boring Mill Table Jaws and Central Clamp

The present practice is to increase the life of bushings by one additional service period by boring the fourth time, scrapping bushings after they are 12 9/32 in. instead of 12 3/16 in. diameter as previously. The advantage as measured in miles and money is about as follows: From a mileage consideration, the bushings of passenger locomotives are bored nearly every time they come through the shops for general repairs. Freight locomotives average three times through the shop with two borings. For the present purpose it is assumed that bushings are bored twice every three times a locomotive passes through the shop. During the past year locomotives in for repairs have averaged 47,000 miles. On the basis of 4½ shoppings as constituting the previous life of a bushing, the bushing mileage would equal 211,500. Under the present system, using bushings with one more boring, would give 282,000 miles, an increase of 33 1/3 per cent. From a money consideration this works out equally advantageously. The mileage credit of the shop for 1920 was 10,427,604. Based on previous practice, the life of bushings was $\frac{10,427,604}{211,500}$ or 49.3 sets of bushings per year. On the present basis of four borings, it becomes $\frac{10,427,604}{282,000}$ or 36.98 sets of bushings per year, a saving of 12 sets, or practically 25 per cent. The cost of a set of bushings with three borings is $98.13, with four borings $108.33. On the above mileage basis, the yearly expense would be 50 multiplied by $98.13, or $4,906; for the second condition, 37 multiplied by $108.33 equals $4,008. The indicated saving is $898. This matter may be considered from another angle. There are roughly 225 locomotives that are using piston valve cages on this road. The previous system would call for $\frac{225}{4.5}$ or 50 sets, and the present method will require $\frac{225}{6}$ or 37 sets per year, if each locomotive comes into shop every 12 months, a saving of 13 sets, or practically 26 per cent. No matter how the question is considered, the advantage is between 25 and 30 per cent, or $100 per month on a road using 225 piston valve locomotives. The cost of bushings is made up as follows:

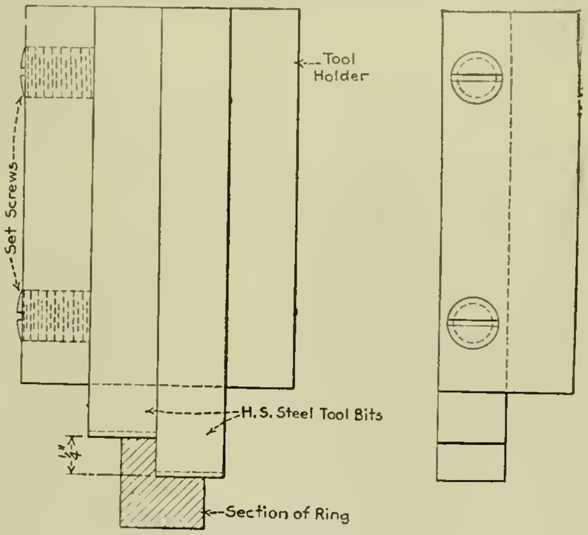


Fig. 3—Arrangement of Form Tool to Face the Top of the Packing Ring

4 bushings H. S. iron, weight 150 lb.	$41.60
Rough boring 8 hrs. at 85 cents	6.80
Turning and fitting, 8 hrs., at 85 cents	6.80
Milling slots, 6 hrs. at 85 cents	5.10
Pressing out old bushings, 2½ hrs. at 85 cents	2.13
Drawing in new bushings, 6 hrs. at 85 cents	5.10
Finishing boring bushings, 12 hrs. at 85 cents	10.20
Two service borings	20.40
	$98.13

A 12 in. bushing with the borings indicated is shown in Fig. 1.

A method has been developed for handling packing rings that has reduced the time and cost of machining the rings 50 per cent. This has come largely through the elimination of one turning, also through the use of a form tool that saves one cut and measurement. The previous method of machining these rings was to rough face them all over, cut out a portion of each ring to get the desired elasticity, close the ends together, and then turn and bore a second time to the finished size. The present practice is to cut out the proper amount of stock, usually ½ in. from the packing pot, clamping the casting to close the slot. The boring mill table jaws will clamp the lower end and a heavy strap clamp in the center is necessary to close the top (Fig. 2). The upper half of the casting is bored and turned to the finished size and a special form tool used to face the top as shown in Fig. 3. Then with the micrometer adjustment the cut-off tool is set in the side post and the ring cut off. It is then complete and ready for assembly on the valve without further turning.

Another time-saving feature in this formed facing tool is that the head on the cross rail may be set to the correct diameter and clamped, no further measurements being required on following ring diameters. The facing tool is simply fed down to the proper depth on each subsequent ring. Casting blanks or packing pots 18 in. long are used, being held by a clamp for the first 10 in. and by the table jaws for the remainder. It is a saving to make a casting as long as a man can conveniently work over the top, and at the same time use a reasonable feed when cutting off rings. A casting can be made into 18, 14 in. finished rings in 8 hours, and this practice has reduced the time by about one-half largely through arousing the operator's full interest in a new machine and giving him adequate encouragement.

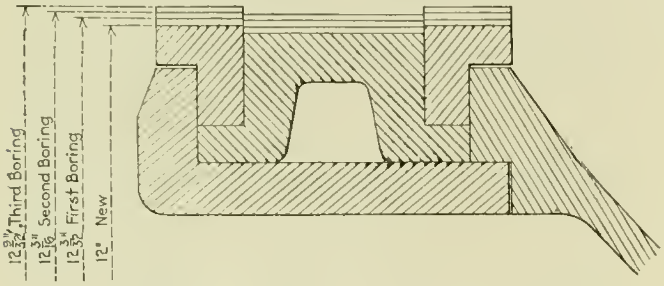


Fig. 4—Standardized Packing Ring with Four Step Sizes

By standardizing packing ring diameters and having only one variable outside diameter, a second service is obtained from large discarded rings. It is simply necessary to turn down the outside diameter to the next smaller size. A new set of rings is applied nearly every time a locomotive passes through the shop, and many more are replaced in engine houses. On the basis of 200 locomotives using one new set per year, 1,600 rings will be used per year costing on an average $1.50 each, or $2,400 per year. Fig. 4 shows the standard ring with four sizes. If this item is followed and half of the rings pass through a second service period, it will save the cost of 800 rings, or $1,200 per year.

These matters are all worth giving attention, for they are the factors which in the aggregate distinguish efficient from wasteful and costly shop operation.

A System for Numbering Shop Machinery

BY J. P. SHAMBERGER

Several years' experience with the Interstate Commerce Commission, inspecting shop machinery and powerhouse equipment, has convinced me that the present system in use on the railroads for numbering machinery is capable of much improvement.

The usual method is to assign the number "1" to some machine at the main shop location, or the shop at one end of the line; then to number all machines consecutively, proceeding from shop building to shop building and from shop location to shop location. In the end, each machine has been given some particular number which performs only the simple primary function of serving as an identification mark. This system may be called good in that any system for numbering is better than none at all.

The system proposed here is known as the Dewey decimal system, used in practically every library in the country for indexing books. Its principal advantages when applied to shop machinery would be: First, the number itself would serve as a partial description of the machine. Second, the numerical arrangement of the cards bearing the machine numbers for any given shop, division, or system would place all machines of the same kind in one group.

The number to the left of the decimal point would represent the type of machine; the number to the right, the individual serial. The division into types may be carried out to an unlimited extent and the number may be made to show not only type, but also size. The type numbers might be as follows:

10 to 19	Lathes
20 to 29	Planers
30 to 39	Shapers
40 to 49	Steam Engines
50 to 59	Steam Pumps
60 to 69	Electric Generators
70 to 79	Electric Motors

and the further division might be like this:

10.	Engine Lathe
11.	Turret Lathe
12.	Wheel Lathe
13.	Wood Lathe
20.	Standard Metal Planer
21.	Wood Planer
30.	Crank Shaper
31.	Wood Working Shaper, etc.

The engine lathe numbers would then be 10.1, 10.2, 10.3, and the numbers for all other machines would be similar.

The assigning of machine numbers should be done from a central office and the type numbers designated by some one familiar with the correct names for the different machines and there should be a print showing the proper place to stamp the number on each class of machines.

If it is worth while to stamp any number at all on a machine, it is certainly worth while to stamp one which will be of the greatest possible service.

A Few Points on Grinding[*]

BY CHARLES H. NORTON

Relatively hard wheels are used for soft material and for small work, and softer wheels for larger work and harder material. The reverse is true if one speed of work only is used and the same amount of material is removed in the same time.

The harder the material being ground the softer the wheel should be, or the faster the work surface, or both.

The softer the material being ground the harder the wheel should be, or the slower the work surface, or both.

The larger the work the softer the wheel should be, or the faster the work surface, or both.

The smaller the work the harder the wheel should be, or the slower the work surface, or both.

The larger the work the longer the arc of contact between work and wheel.

To counteract the effect of longer arc of contact the surface speed of the work must be increased. In fact the cutting action of the wheel can be controlled entirely by the work speeds.

The slower the work revolution and the softer the wheel, the deeper the cut may be, and with this combination a maximum amount of metal can be removed in a minimum time with a minimum loss of wheel and consumption of power.

Relatively fast work revolution with soft wheel causes the wheel to wear away rapidly.

The faster the work revolution the harder the wheel must be, whether roughing or finishing.

Slow work revolution, hard wheel, and deep cut cause the wheel face to load with steel, preventing the wheel cutting.

The slower the work revolution the softer the wheel must be, whether roughing or finishing.

Slow work revolution, and hard wheel with light cut cause the wheel to glaze, preventing the wheel from cutting.

By the use of the variable work speeds of grinding machines, it is possible to use on small, hard material the wheels graded for large, soft material and vice versa.

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[*] Abstracted from Grits and Grinds, 1921. Copyright by Norton Company, Worcester, Mass.

Floodlighting for the Turntable and Lead Tracks. Photograph by the American Lighting Company, Chicago

Electric Power and Light for Railroad Shops*

The Trend of Development and Standards Adopted in the Power and Lighting Field

BY J. E. GARDNER

Electrical Engineer, Chicago, Burlington & Quincy

THE Electrical Department of a steam railroad has a varied field in which to work, comprising the mechanical department, the building department, the water service department, in fact, the whole engineering department, and it handles both power and lighting installations as well as welding and electric furnace installations.

Electricity is being adopted as the form of energy for various uses, because it means, in practically every case of its use, a direct economy to the railroad, and this question of economy of operation must be considered in planning any new installation. In most cases, this can be calculated in actual dollars and cents. The reliability of electrical operation is an important factor and it is the aim of the electrical department to make reliability and dependability its first consideration in laying out an installation, including due observance of "safety first" measures.

The rapid growth of the electrical industry may be seen from the fact that in 1915 the motors in the United States served by central station power amounted to a total of 6,100,000 horsepower, whereas in 1920 they totaled over 12,900,000, an increase of over 100 per cent in five years. Similarly, the number of incandescent lamps sold per year increased from 4,000,000 in 1890 to 110,000,000 in 1915 and 231,000,000 in 1920, also an increase of over 100 per cent in the last five years.

Alternating Current vs. Direct Current Power

One of the very first considerations in a power installation is the proper type of power to adopt. If power is to be purchased, it will nearly always be found that the power company can supply three-phase alternating current, and can supply this at a cheaper rate than the direct current in cases where it can furnish either. In cases where power is to be generated, three-phase alternating current is fast becoming the current adopted, and for very good reasons.

For transmission purposes, three-phase power is unquestionably the preferable type, as the use of transformers gives the choice of all voltages for any one installation and allows the same power to be efficiently converted to 110 volts for lighting purposes.

The three-phase motor, especially the squirrel cage type, has many advantages over the direct current motor wherever a constant speed motor can be used. It has no commutator to give trouble, and in the case of the squirrel cage motor it has no moving electrical contacts or brushes whatever, and no rubbing parts except the bearings. The manufacturers have now developed rotors to squirrel cage motors that are almost indestructible, and so long as the bearings are kept properly lubricated and the motor is not improperly overloaded it will run indefinitely without giving trouble.

The control of a squirrel cage motor is of the simplest possible type to operate. The starting of such a motor by hand control consists, in the case of the smaller motors, merely of throwing in a switch, and in the case of the larger motors, of throwing the double throw switch of a compensator. The stopping of such a motor consists merely in the throwing out of the switch, either directly or by means of a push-button. Further, this push-button, or in fact a series of push-buttons, can be located at convenient points for stopping the motor either for its regular operation or in emergency. In short, the squirrel cage motor is the most rugged and fool proof motor obtainable, and should be used wherever possible. It has, however, the characteristic of lower starting torque than can be obtained from the slip ring motor, which makes the slip ring motor necessary for starting machinery that must start under heavy load, as air compressors, triplex pumps, etc.

The direct current motor has to its credit the variable, or adjustable, speed that can be obtained from it and is used wherever possible, when this quality is of prime importance. For this reason, many large shops furnish both three-phase and direct current, using the direct current where adjustable speed is needed. However, even in such cases the ordinary procedure is to generate three-phase current first and convert this to direct current by a motor generator set or a rotary con-

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*Abstract of a paper presented before the Western Railway Club, March 21, 1921 verter, so that the direct current immediately becomes more expensive to generate, due to the losses in this apparatus.

Furthermore, alternating current is coming to such universal use that many manufacturers are furnishing sufficient speed changes in their standard machine tools to permit the use of a constant speed motor. In very many cases it is cheaper to purchase a tool with sufficient speed changes to permit the use of a squirrel cage motor than to purchase a tool without such changes, but with an adjustable speed direct-current motor.

For traveling crane drive, the direct current series motors have the advantage that their light load speed is much faster than their full load speed, which makes the operation of the crane faster when handling light loads or running light.

The use of synchronous motors is to be considered in the case of large motors which run practically all of the time under fairly steady load, as for instance the motors of motor generator sets or motor driven air compressors. This is especially desirable where alternating current is generated at the shop or where the power company furnishing current demands a penalty for low power factor. The use of such a synchronous motor in a power plant will raise the power factor of the plant instead of lowering it, as is often the case when such apparatus is driven by large induction motors. In cases where the alternating current generating equipment has become overloaded it should be investigated to see if the use of a synchronous motor will not overcome the trouble before recommending additional generators.

Individual vs. Group Drive

In the days when the machinery in the shop was driven by steam power, the usual procedure was to have one large engine drive all of the machinery in one shop. When these engines began to be superseded by electric motors it was found to be of considerable advantage to divide the shop into various groups handled by separate motors, and in the case of certain machines to drive them by individual motors. In this way it was possible to eliminate a great deal of the friction caused by the large amount of shafting, belts, etc., in the shop, and also to operate part of the shop without the necessity of running all of the shafting. The growing use of traveling cranes for machine shops has aided to develop the use of individual motor drive for machine tools, as this does away with all of the shop shafting. Individual drive also gives the added advantage that the tool can be quickly located in any position in the shop. However, in shops, or in shop bays, not equipped with traveling cranes, and especially for the smaller tools, the advantage of individual drive is in many cases neutralized by the added cost of the necessary motors for such drives.

The horsepower of the motors in a shop equipped with individual drive would be much more than in a shop equipped with group drive, and the cost of the motor installation will show a much greater contrast owing to the fact that the smaller motors cost more per horsepower than the larger motors. In the smaller railroad repair shops especi- at the same time. If individual drive is adopted, each motor must be large enough to handle the maximum load on that machine tool, and in the case of reciprocating machines, as planers, slotters, etc., the motor must be large enough or the machine must be equipped with enough flywheel capacity to furnish the momentary energy required to reverse the machine at the end of the stroke. In the case of group drive, all of the energy stored in the shafting and various machines of the shop is available at such an instant, and this fact makes a still greater difference in the horsepower required with the group drive as compared to that with the individual drive.

Furthermore, with a shop using only alternating current a few motors loaded nearly to capacity will furnish a much higher power factor than a large number of motors carrying light loads. This is of special importance if the shop generates its own electric power.

Consequently, before deciding to adopt individual drive throughout an entire shop, it must be carefully considered as to whether the additional cost is warranted, as compared with group drive, especially for the smaller machines.

In laying out group drive for a shop, such as is found at a roundhouse point, it is advisable to put certain tools that are likely to be used at any time for emergency work in a group by themselves so as not to necessitate running of a large number of tools during the night.

Standardization of Motor Speeds and Voltages

The size and first cost of a motor decrease as the speed increases, consequently in designing a motor drive care should be taken to see that a motor of the highest practical speed is used. For gearing or chain drive, the speed of the motor must be selected with care not to exceed speeds in good practice, taking into consideration the size of the motor. For belt drive, the size of the two pulleys and the reduction of speed permissible with one pair of pulleys determines the motor speed that must not be exceeded. For 60-cycle, three-phase motors the speeds most commonly used are no load speeds of 1,800, 1,200, 900 and 720 r.p.m., with full load speeds approximately 5 per cent less, and a safe plan to follow for a belted motor is to see if a 1,200 r.p.m. speed can be used and work as near to this speed as possible without getting too great a pulley ratio.

Basing the price of 1,200 r.p.m. motor at $100 for the sake of convenience, the relative price of motors of the various speeds is approximately as follows:

Speed in RPM.	Comparative cost
1,800	$77
1,200	100
900	125
720	142
600	158

In order to standardize on motor speeds, the manufacturers are furnishing direct current motors with approximately the same speeds as the full load speeds of alternating current motors. It is also, of course, a decided advantage to the motor user to keep the motor speeds as near standard as possible, and this should be considered in selecting motors.

The advantage of a spare motor, and the ease with which motors can be transferred from one tool to another in a shop is increased to the extent that such standardization is perfected. Another argument in favor of motors of speeds of 1,200 or 900 r.p.m. is that they can be more readily purchased.

Voltages should also be standardized as far as possible for the various shops on one railroad. For direct current, 230 volts is beyond doubt the best for power. For three-phase current, 220- and 440-volt motors are both used, and the majority of the induction motors manufactured can be reconnected for either voltage. For a good-sized shop the cost of copper wire for power circuits is a large item, and if 440 volts is used instead of 220, the circuit wires will be half the size, and feeders, when the voltage drop determines the size, can be one-fourth the size. For this reason 440 volts is recommended for a standard.

When a fuse blows, the motor is shut down until the fuse is replaced, a condition which means a delay, and in many cases a serious delay. When a circuit breaker throws out it is only a matter of seconds for the operator to throw it in again and have the motor running. For this reason, circuit breakers or overload relays are recommended for use on every electric motor and are well worth the additional cost in time saved. For induction motors overload relays will be used in connection with the compensator, oil switch, or other starting device.

The "safety first" campaign in all industrial lines has been the means of bringing out many new types of safety switches and safety devices, most of which are commendable. Safety switches mean protection against personal injury, against fire and against power failures. In addition to the safety switches, many panel boards now have the fuses of each polarity or phase in a separate compartment, the different compartments being separated by barriers. Compensators can now be obtained with the relays and no-voltage coil complete inside of the same case as the compensator, which adds to the convenience and neatness of wiring. Automatic starters can be purchased complete with enclosing cabinets so that they can be located close to the motor without need of additional protection, and so that a complete conduit installation can be made.

Pumping Plant Operation

The present high price of labor, gasoline, kerosene and coal combine to make electrical operation economical in many pumping plants and coaling stations where electric power is available. In many cases the use of automatic control is the determining factor in reducing the cost of labor for operating a pumping plant. However, no automatic devices are absolutely infallible, and where hand starting can be operated without great additional expense it is advisable, as it makes it necessary that the attendant visit the plant at least once every time the motor is started. Pumps do not always prime properly, pumps and motors have to be oiled at regular intervals, bearings run hot occasionally, so that it is not fair to any equipment, however reliable, to expect it to operate day in and day out without attention.

In the case of the most important water stations, duplicate equipment is recommended for protection in emergency, and where such stations are operated by automatic control, a hand controller is recommended in addition to the automatic controller, this being so connected that reversing a double-throw switch cuts the motor control on either the hand controller or the automatic starter, and disconnects the other entirely so that it can be taken out for repairs without shutting down the plant. The writer has installed this equipment in three important pumping stations, and its value in time of emergency has been well proved.

Automatic Control for Shop Motors

Automatic control is slowly being introduced into the railroad machine shops for controlling certain machine tool motors. The arguments in favor of automatic control are that it enables any operator to start the motor properly, that the motor control may be placed where most convenient to the operator, and that with direct current motors dynamic braking may be used to stop the motor almost instantaneously when necessary.

In the case of direct current wheel lathe motors, an added argument is that the motor may be momentarily slowed down by the push-button control at times when the tool strikes a hard spot on the tire.

The reversing planer motor is a recent adaptation of automatic control, which is successfully used to speed up the operation of planers both for large and small work. For this equipment, a special motor is used that will stand starting, stopping and reversing at each stroke of the planer. With this control a great time saving is made by the readiness with which the cutting speed or the return speed may be regulated, each independently of the other by elimination of belt slip and by the quickness with which the operator can start or stop the motor either in the regular course of its duties or while setting up work.

Elevator Control

Automatic control is now being successfully used to operate both passenger and freight elevators. One serious disadvantage in the use of automatic control for freight elevators has been that if the car was adjusted to stop at the floor level when carrying a heavy load, it would not stop at the floor level when carrying a light load, making it hard to handle trucks in and out of the elevator. Elevator equipment can now be obtained, however, having a small motor driving the armature of the main elevator motor at slow speed through additional gearing, and by using special leveling cams at each floor level so that when the car reaches the floor at which it is to stop the main elevator motor stops and the small leveling motor then picks up the control, brings the car absolutely to the floor level, and holds it there. With the present high price of labor, such a device often means considerable saving.

Interior Lighting

The rapid development of incandescent lamps within the last few years has added entirely new possibilities in the electric lighting field, and the intensity of illumination which is recommended to be supplied has increased year by year. From a railroad point of view, we see in this two separate phases. First, utility lighting in shops, roundhouses, offices, yards, etc., where the lighting is for the advantage of the railroad employees. Second, lighting that must have a certain decorative value, as railroad trains, stations, and such places where the lighting is for the benefit of railroad patrons as well as railroad employees. A study of the situation shows that in practically every case the amount of light furnished is much greater than it was a few years ago. In the case of shop lighting, yard lighting, etc., it has been proved that by furnishing general illumination of sufficient intensity, the efficiency of the workmen is greatly increased as well as the quality of the output and the protection against accidents.

Until recently it has been the custom to employ mechanics for night work at roundhouses, etc., and expect them to do good work with the light of an oil torch. The recent increased cost of labor brought out the fact faster than it would otherwise have been brought out that it is absolute economy to furnish proper lighting at such points, especially where work is being done all night long. The cost of electric lighting is a small item compared to the total cost of operating a shop, so that the question must be carefully considered at each shop as to whether sufficient illumination is provided. A record of eight years ago shows that as low as two foot-candles was recommended at that time for machine shop lighting, whereas the latest recommendations are from five to ten foot-candles. By furnishing general illumination of sufficient intensity the use of portable cords can largely be done away with. A portable cord has always been an expense to maintain, and the small lamp used with the portable cord, as well as the lamps used for drop lights, have always been a source of expense due to breakage and theft. By lighting the shop with large lamps located in suitable reflectors at a considerable height above the floor, trouble due to lamp breakage, theft and lamp cord maintenance is done away with, and at the same time much better lighting is obtained.

The only recent important addition to the available lamps is the bowl enameled gas filled lamp. This lamp is designed for use in the standard reflectors, the enameling being to dispense with the glare caused by a bare gas filled lamp when placed low enough to be in the line of vision.

Yard Lighting

The use of large Mazda lamps has made possible lighting of large outdoor areas by the use of flood lights. A few years ago the method of lighting a hump yard, or in fact any freight yard, was to install rows of arc lights between the tracks or suspended over the tracks. At a later date the Mazda lamp superseded the arc lamp, still using the large number of lamps distributed through the yard. Now, by the use of a few flood lights located at proper points, much better illumination can be obtained and the cost of maintenance reduced. For a hump yard, a flood lighting tower located at the top of the hump will enable the car riders to see ahead of them almost as distinctly at night as in the daytime, and thus permit them to carry their cars as far from the hump as possible and yet avoid damage to the cars or contents.

For best results, these flood lights should be located not less than 50 ft. from the ground, and preferably, at least 75 ft. For lighting the larger areas, 1,000-watt lamps should be used, and the reflectors of the flood lights should be of mirrored glass or metal that will not easily tarnish. This latter is a point that must be carefully considered, as the average flood light does not get the attention that a locomotive headlight reflector receives. In cases where one 1,000-watt lamp is not enough to light a given area, the usual practice is to install a battery of several of these lamps. By slight changes in the focusing and position of the different reflectors, the light can be distributed over the proper area. The use of flood lights has the decided advantage of leaving the space to be lighted largely free from poles and overhead wires. In the case of a cinder pit, especially where the cinders are handled by a clam shell, the lighting has always been difficult and hard to maintain. The use of flood lights placed at proper points at the end of the cinder pit will improve this condition wonderfully.

One point that must be carefully noted in laying out a flood light installation is that the flood light should be placed, as far as possible, so that it will throw its light parallel to the tracks. If the flood light is placed so that it has to throw its light at right angles to the tracks, any cars or locomotives standing on the tracks will throw dark shadows at the very place it is desired to light.

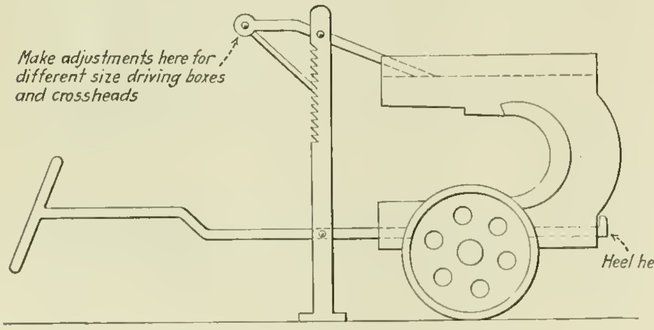
Flood lighting is well adapted for the purpose of lighting long freight or passenger platforms where these are not covered by canopies, but if not located at a sufficient elevation they will cast a disagreeable glare.

Truck for Driving Boxes

BY J. H. HAHN

Assistant Machine Shop Foreman, Norfolk & Western, Portsmouth, Ohio.

A shop truck designed especially for hauling driving boxes but which can also be used in moving crossheads from place to place is shown in the illustration. No dimensions are furnished with this sketch owing to the fact that the truck will have to be designed to accommodate the driving boxes and crossheads on the particular road for which it is made. The principle of operation of the truck is evident, however, and heavy driving boxes and crossheads can be moved from one machine to another and from one department to another with a minimum of physical effort.



Shop and Roundhouse Truck for Handling Driving Boxes

A pair of comparatively large diameter wheels are mounted on an axle attached to a plate which fits in the shoe and wedge way and has a heel on one end to hook under the box. On the handle side of the truck is a swinging arm to which is attached a lever and notch arrangement for holding the box in place when tipping up the truck.

In operation the driving box is turned upside down on the floor and the truck brought into position with the heel tipped down and under the driving box. The box is then clamped in place with the arrangement shown and a downward pressure on the handle of the truck will then lift the driving box off the floor. The design of the truck is such that the center of gravity with the driving box in place lies approximately over the axle so it is easy to handle the truck and move it from place to place. Adjustments are made for different sizes of driving boxes by means of the clamping arrangement shown. An extension to the swinging arm serves to support the truck and box in a horizontal position when desired.

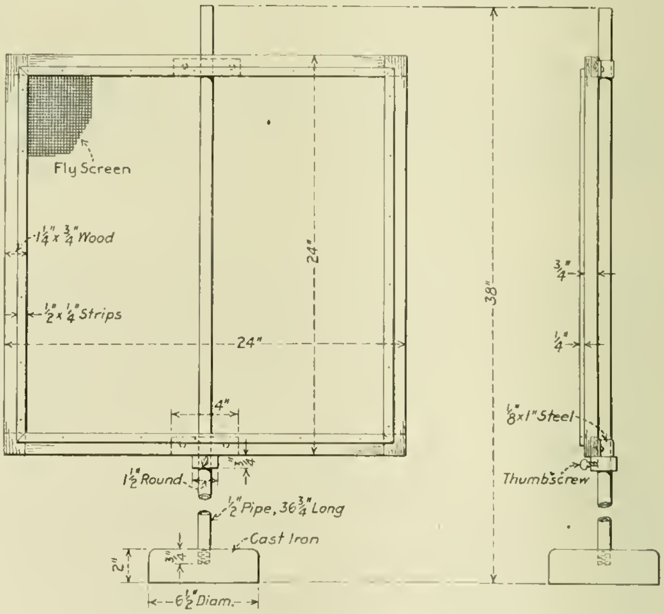
With this device, driving boxes and crossheads have to be lifted only a short distance from the floor and they can be moved from one part of the shop to another with a minimum of effort.

An Improved Chipping Screen

BY A. G. JOHNSON

Mechanical Engineer, Duluth & Iron Range, Two Harbors, Minn.

The well-organized movement to reduce accidents by safety first campaigns has accomplished desirable results. One of the points most strongly insisted upon has been the provision of suitable means to prevent accidents by flying chips. The chipping screen illustrated was designed for this purpose and is convenient, being readily adjustable in position and elevation on the work bench. As illustrated, the screen consists of a wooden framework made from 1¼ in. by ¾ in. stock. Strips, ½ in. by ¼ in., are provided to hold the fly screen in place on the framework and the latter is arranged to swivel on a piece of ½ in. pipe threaded into a cast iron base sufficiently heavy to hold the screen in an upright position. The collar and set screw, indicated, provide for easy adjustment of the screen vertically.



Convenient Type of Adjustable Chipping Screen

A screen of this general type may be arranged with two or more hinged wings which can be set or clamped at any angle for use around a boring mill when turning brass. This confines the chips to a small floor area and helps to save the scrap brass. When not in use, the wings can be shut and set against the wall out of the way.

Locomotive Main Rod Angularity

BY WILLIAM ULRICH

Foreman Valve Setter, Delaware, Lackawanna & Western, Scranton, Pa.

There has been considerable discussion of the subject of irregularity in valve motion due to locomotive main rod angularity and other errors which must be overcome to obtain a square valve gear. Main rod angularity and the difference in elevation of cylinder and driving wheel center lines have introduced errors which must be overcome and this article is intended to show the effect of these two errors; how one overcomes the other on one side of the locomotive and increases the error on the other side; how the roll of the engine, which cannot be fully counteracted, constantly changes these errors. It is hoped to give the practical valve setter a clearer idea of the subject under discussion and point out the advantage of working from the front centers in setting valves. Too frequently the assumption is made that the largest errors in valve motion are due to main rod angularity when the trouble due to other causes is far more serious. In reality, the errors due to main rod angularity have little effect upon the valves.

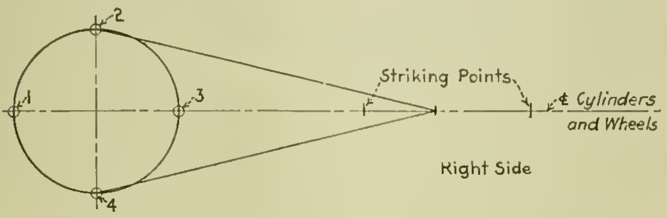


Fig. 1—Crank Pin Positions When Center Lines Coincide

With locomotives of today, having long main driving rods, angularity has much less effect than when main rods are short, as in the case of locomotives of older design. Angularity is less, on account of the longer radius, although this decrease is slightly offset by the longer stroke of modern locomotives. The effect of relative main rod length and piston stroke will be readily understood from reference to Fig. 1, which shows four crank pin positions corresponding to the two dead centers and the top and bottom quarters.

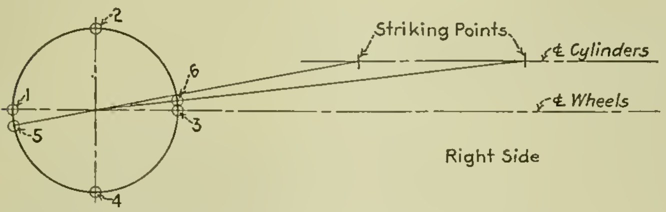


Fig. 2—Diagram Showing Effect of Raising Cylinder Center Line

Dead Centers Not Diametrically Opposite

The cylinder center lines on nearly all locomotives are from 1 in. to 3 in. higher than the center lines of the wheels, thus bringing the dead centers not diametrically opposite. By studying Fig. 2, it will be evident that a slight error exists. The rear dead center is at *5* and the front dead center at *6*. If the cylinder center line was at the same elevation as the center line of the driving wheels, as shown in Fig. 1, arc *1-2-3* would be equal to arc *1-4-3* and the dead centers would be opposite each other. In Fig. 2, arc *5-1-2-6* is slightly longer than arc *6-3-4-5*, the difference being an error due to the difference in elevation of the center lines.

For convenience, it will be considered that Fig. 2 represents the right side of the locomotive. With the locomotive on the front dead center (right lead engine), the left crank pin would be in position *1*, Fig. 3, or if on the back center, position *2*, Fig. 3. The greater the difference in cylinder and driving wheel center line elevation, the greater will be this error. The error is practically negligible for differences in center line elevation not exceeding 3 in. and it is impossible to figure it exactly as valve setting in the back shop is generally done while the locomotive is being assembled. When the boiler is filled with water and the locomotive settles on its springs, the center lines of wheels and cylinders come closer together, and when the locomotive is working, the roll constantly changes this distance. In setting valves, it is good policy to work from the front centers as much as possible since they are near the center line of motion.

The position of the right crank pin when the left pin is on either front or back center, is shown in Fig. 4. When the left crank pin is on the front center, the right pin will be 90 deg. ahead, or at position *2*, and when on the back center, position *1*, Fig. 4. This shows that the error due to the dead centers not being diametrically opposite helps offset the error due to main road angularity on the left side and increases the error on the right side.

The position of the left crank pin with the right pin on either front or back center is shown in Fig. 5. If the piston was at the center of the stroke, the main pin would have to be on points *A* or A_1. It will be noted that when the right crank pin is on the front dead center, the left pin would have to be at point *A* to bring the piston to the center of its stroke. In reality the left crank pin is at *B* and there is an error equal to the distance between points *A* and *B*. When the right crank pin is on the back dead center, the left pin would be at point A_1 where it is (in this case) due to the fact that the two center lines do not coincide. If they were in the same line, an error would exist equally on the front and back centers. On the right side the longer arc between points *1* and *2* (Fig. 4) is toward the front and the offset from the center point of the stroke is increased. This error will be about ⅝ in. It will be more with a shorter main rod and less with a longer main rod, and it will also be more with a longer stroke and less with a shorter one.

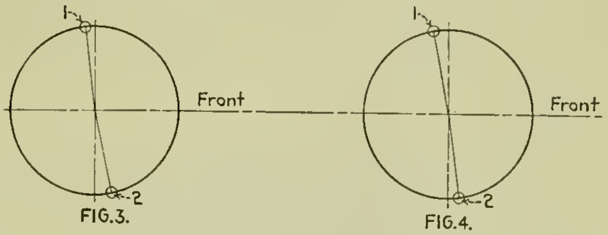


FIG.3. FIG.4.

Figs. 3 and 4—Left and Right Crank Pin Positions with Opposite Crank Pins on Dead Centers

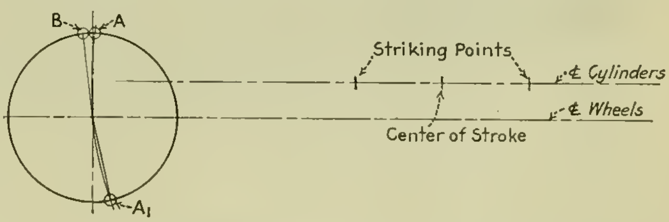


Fig. 5—Diagram Showing How Error Due to Angularity is Increased on Right and Decreased on Left Side

Methods of Counteracting Errors

The above irregularities are overcome in the Stephenson valve gear, however, by offsetting the link saddle, although this feature of design must take care of other errors, such as those due to eccentric blade angularity, and the location of the eccentric blade pins back of the link arc. In the Walschaert gear, irregularities are overcome by the back set of the link foot, which also takes care of the angularity of the eccentric rod.

These errors are greater at 50 per cent cut-off than they are on a shorter or longer cut-off, as when the crank pin is nearer the centers (either front or back), the piston is not traveling as fast as when it is on the top or bottom quarter. In other words, the wheel must revolve farther with the crank pin near the dead centers to move the piston a certain distance than if the pin was on the top or bottom quarter.

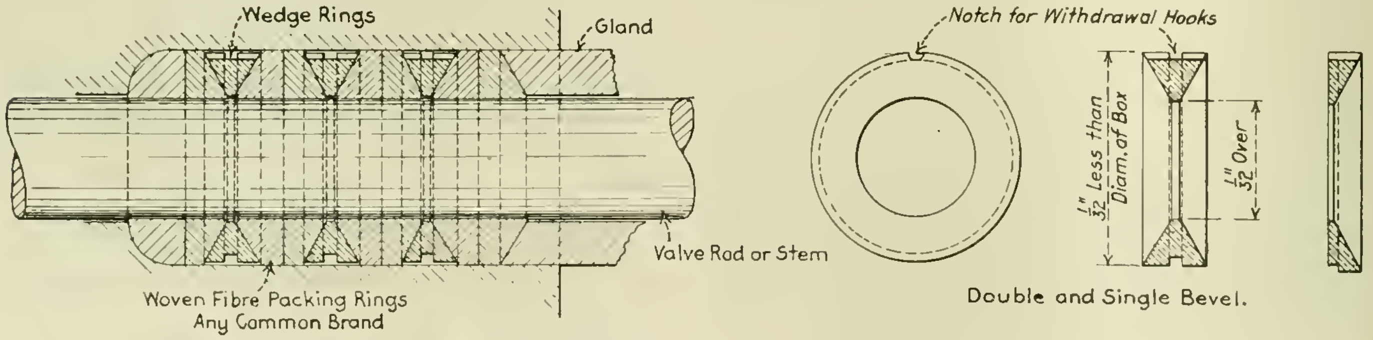
Increasing the Efficiency of Piston Rod and Throttle Packing

BY FRANK ROBERTS

The writer has made many comparative tests on both air pump piston rod, and throttle valve stem packings. Among the packings tested are included both metallic and the usual fibre braided packings, varying in price from a few cents to over two dollars a pound. The conclusions deduced below are the direct result of this service test study.

It is evident to any railroad man who has spent much time around an enginehouse, that the majority of packing is removed from service, not because it is worn out, but because it leaks steam and is no longer serviceable. What usually causes removal under the action of service conditions in stuffing boxes, is not an appreciable wear, but the loss of elasticity. The heat and pressure dries and hardens the plastic fibre rings until they are absolutely non-resilient. No amount of pressure applied at packing gland nuts will cause the rings to close around the rod or stem sufficiently to hold back the escaping steam.

The engineer reports packing blowing and the repair man removes the old and applies a new set of packing. A casual glance about any enginehouse scrap box or yard will show how many apparently perfect rings are thrown away. Examination will show that these discarded rings are as hard as bone but the inside wearing surface is polished and perfect. All it requires is a means of pressing it close against the rod to seal the joint and hold back the steam. With proper compression there is no reason why rings will not give good service for a period at least double that now obtained.



Wedge Rings Hold Old Packing Tightly Against Valve Stem, Preventing Leaks

The use of wedge rings, shown in the illustration, will effectively compress packing rings long after they have lost their resilient properties. Even after they become quite hard a moderate pressure from the gland nut, operating through the bevelled dividing faces, causes a wedging action that forces the packing rings against the rod, effectively compressing the rings long after they have lost their resilient properties. This wedging action forces the packing rings against the rod, effectively preventing the escape of steam. Our finding is that the life of rings is increased over 100 per cent.

Another decided advantage resulting from doubling the life of a set of throttle packing is the money and time saved by not having to blow down the boiler so often for changing the throttle packing. This is an expense which is not incurred, however, when changing a set of air pump rod packing.

The item of lubrication is perhaps a leading factor in satisfactory packing service. The pumps are not so hard to lubricate if proper swab rings are applied, and supplied with oil, but the throttle stem is a different problem. A deep packing box, several times exceeding the total travel of the stem is used, and any oil applied to the stem outside of the packing box gland is carried only a little way into packing box, reaching only the first rings. The rings next the steam never get any of the oil, and soon dry out hard, losing their ability to hold back steam.

The cost of wedge rings is of no special moment, in fact less than the cost of the fibre rings displaced during the first application. They may be used repeatedly if made of brass and can be easily cast, thus eliminating all machine work and bringing the price down to a few cents each. The rings will save time, trouble, and expense.

The Use of Hack Saw Blades*

It is better to err in using a hack saw machine blade a few gages too heavy rather than one gage too light, as this practice will result in much less breakage.

Never use a coarse tooth blade on thin sheet metal or tubing of any kind as the teeth are bound to strip or the blade become broken.

For cutting solid material of all kinds, 14- and 18-point blades may be used to good advantage.

Where gages from 16 to 21 are being cut (either tubing or sheet metal) a 24-point blade will give best results.

When cutting material finer than 21 gage in any metal, a 32-point blade will give best results.

Extreme care must be used in weighting a blade when cutting unannealed tool steel as too much weight on a new blade will ruin it quickly.

Never buy a cheap hack saw blade as the cheapest is usually most expensive in the end.

Experience has proved that 90 per cent of hack saw troubles are caused by using blades on work for which they were never intended.

If in doubt as to the kind of blade to order, ask the manufacturer and he should be able to give you assistance.

What is Probably the greatest "layoff" which ever occurred in the transportation industry took place between August, 1920, and March, 1921, when, according to the statistics of the Interstate Commerce Commission, the total number of employees on the Class I railroads decreased from 2,197,824 in August, 1920, to 1,593,068 in March, 1921, representing a decrease of 604,756, or 27.5 per cent.

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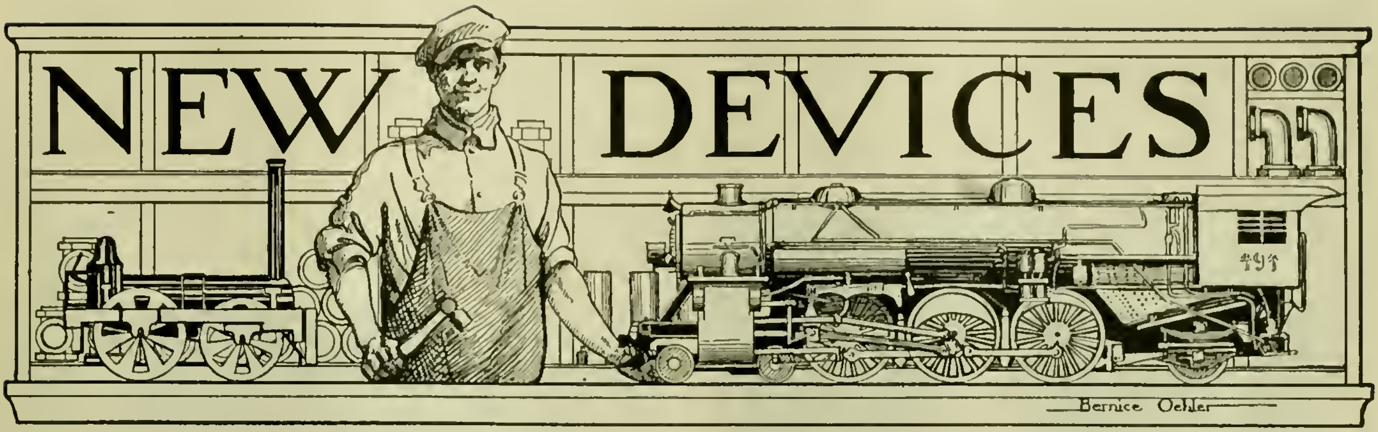
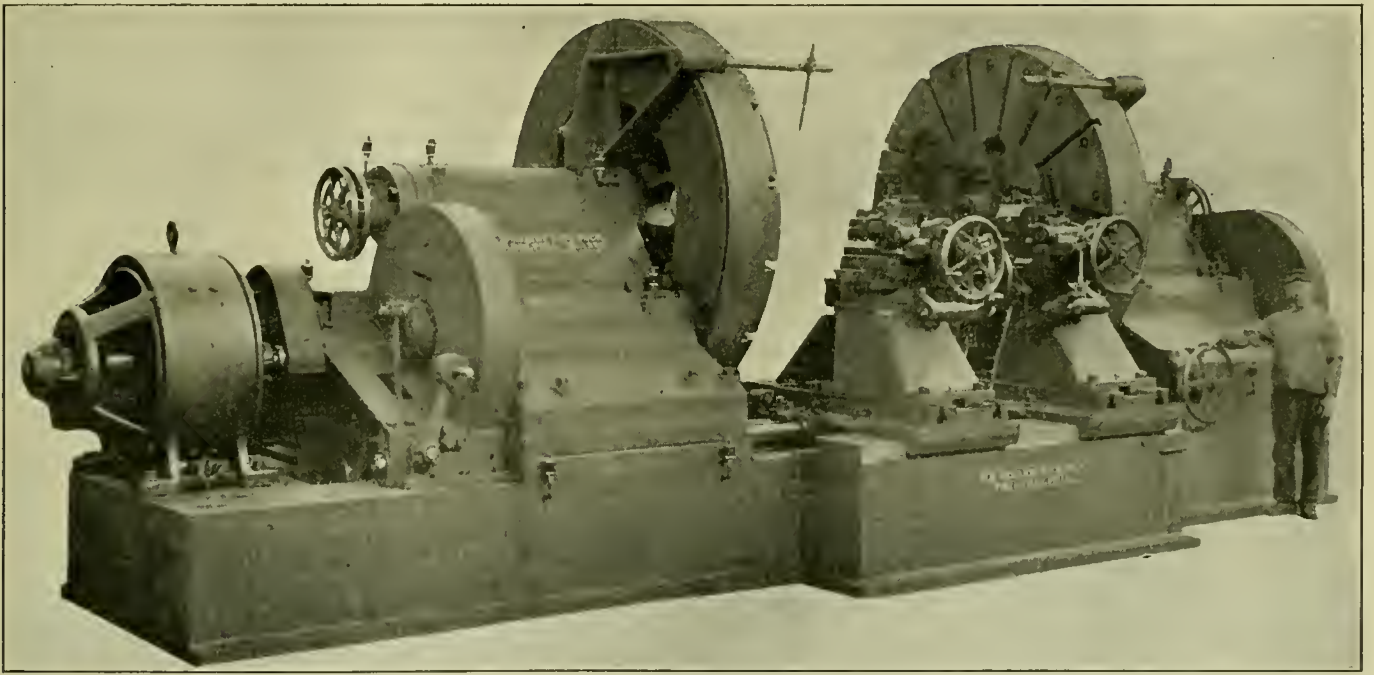
*From a circular issued by the Diamond Saw & Stamping Works, Buffalo, N. Y.



Heavy Pattern 90-In. Driving Wheel Lathe

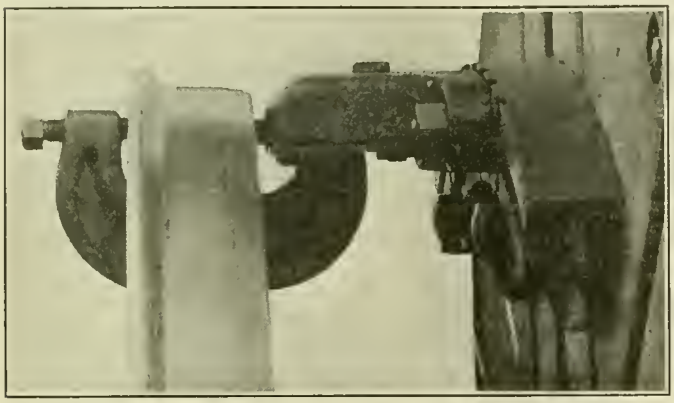
MODERN facilities for wheel turning, quartering and journal turning are combined in the heavy pattern 90-in. wheel lathe, illustrated, which has been developed recently by William Sellers & Co., Inc., Philadelphia, Pa. As usual in this type of lathe, the left-hand head is bolted to the bed in a fixed position, while the right-hand head is adjustable for putting in and taking out the mounted wheels. The adjustment of the sliding head is accomplished by a motor, driving through a slip clutch to insure the proper pressure being put upon the lathe centers. This also provides a safeguard against overstrain or breakage, during adjustment. The heads are massive and each one carries a rotating spindle with an internal geared face plate. A sliding spindle supports the conical centers which are adjustable longitudinally to suit the different relations of the tire to the ends of the axle. Hand-wheels are provided at the ends of the heads for adjusting the centers longitudinally and for locking them in position.


Sellers 90-in. Driving Wheel Lathe Equipped with Direct Current Motor Device

The bed is a heavy iron casting of box construction with the center line of the spindle carried vertically over the back shear, insuring that the resultant pressures due to the cuts will fall within the limits of the base, even for the largest diameter wheels. This feature is important in eliminating deflection and chatter.

All of the tools necessary to complete the turning, from roughing to form finishing, are assembled and carried in turrets mounted on top of each tool slide as illustrated. In order to release the clamp and lock for the turret, preparatory to bringing a set of tools into operation, it is only necessary to make a slight turn of the clamp pin in the center and raise the locking cams *A* as illustrated. After swinging the turret 90 deg. the locking cams are dropped into place and the clamp pin given a portion of a turn, fixing the tools in position for the desired cut.

Another important feature is in the method of driving the wheels under the cut. On each of the face-plates are mounted two patented C-clamp drivers, illustrated. These drivers consist of sub-bases quickly and easily adjustable in the T-slots of the face-plate for the varying diameters of the wheels. The driver bases have a circumferential adjustment on the sub-bases to compensate for the layout of spokes and counterweights for different types of wheels and each driver base carries a sliding driver bit of hardened steel, with serrated teeth, the edges of which are pulled against the outer side of the tire by a C-clamp. Owing to the freedom of the bit and C-clamp to move or float endwise with relation to the driving base and face-plate, this type of driver accommodates itself to the rim of the wheel and does not have any tendency to distort the rim, while holding and driving it firmly into the cut. As there are only two drivers required on each face-plate, the amount of time and effort consumed in clamping is reduced to a minimum.

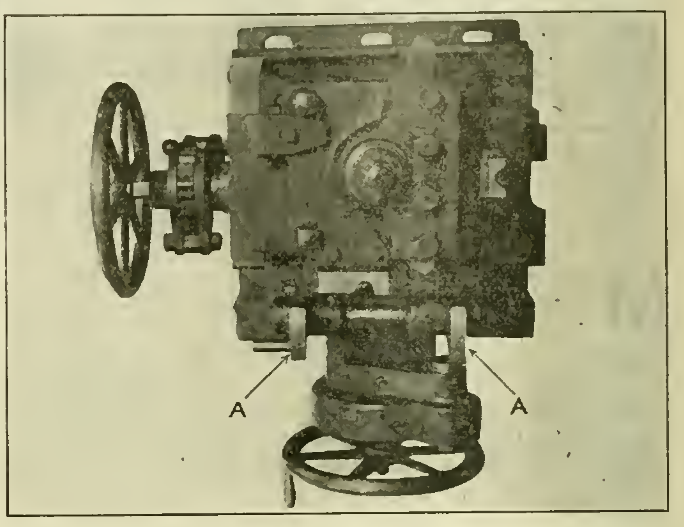


Non-Distorting Arrangement for Bolting Tire to Face Plate

Difficulty from grit on the slides has been overcome by making the wearing surfaces of hardened steel. These surfaces are carefully ground and fitted and oil pockets filled with woolen waste are used as reservoirs for supplying lubrication.

The drive for this machine is simple, no change gears being used in the direct current drive, except for changing the range from the wheel turning to journal turning speeds. A 50-hp. motor with a three to one speed variation produces a range sufficient to cover all requirements. The speeds are from ½ to 1½ r.p.m. for wheel turning and from 3½ to 10¾ r.p.m. for journal turning. When alternating current drive is furnished, a geared speed change device is substituted for the variable speed motor and this in turn is driven by the alternating current motor coupled directly to it.

This machine can be equipped with either of two forms of journal turning attachment. One is arranged to turn two inside journals up to 23 in. in length at one time and is mounted on a transverse bed. Power traverse is provided for moving it out of the way when handling wheels and during such other time as the attachment is not required. The second journal turning attachment turns but one inside journal at a time and must be removed from the bed when the wheels are being turned. Both of these attachments have a power cross feed for facing hub liners, etc. The quartering attachment consists of a separate boring head driven by an independent motor and mounted upon one or both heads of the machine.



Tool Slide and Turret Equipped with Roughing Tool, Flange Roughing Tool, Flange and Tread Finishing Tool and Chamfering Tool

Buckeye Six-Wheel Freight Car Truck

In the description of the Virginian 120-ton coal car, published in the March issue, brief reference was made to the six-wheel truck manufactured by the Buckeye Steel Castings Company, Columbus, Ohio. The new design which was used on 500 of these cars differs in several respects from the earlier form of this truck.

These trucks are of much interest, not only as a new development in high capacity freight truck design, but especially because they are designed to retain practically all of the fundamental advantages which have contributed to the recognized success of the present type of A. R. A. four-wheel cast steel truck.

Generally speaking, this latter type of truck owes its popularity principally to the following: (1) Perfect equalization of load regardless of condition of springs or tracks. (2) Accessibility of parts for maintenance and inspection. (3) Flexibility and short wheel base, facilitating operation over uneven tracks, inclines and sharp curves. (4) Brake sus-

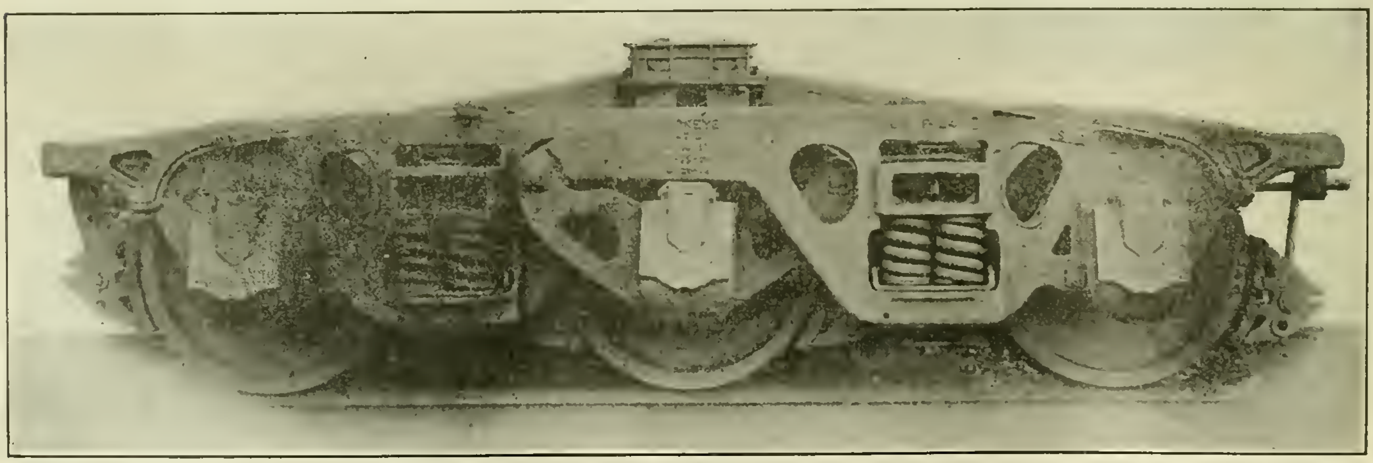


Fig. 1—A Side View of the Buckeye Six-Wheel Truck

pension arranged from parts independent of spring travel. (5) Safety of the detail structures by avoiding having any part carrying load subjected to direct tension.

Method of Equalization

The equalization of the load in the Buckeye six-wheel truck is accomplished by the use of the equalizer casting which engages the center journal as shown in Fig. 1. The side frame castings are so designed that two-thirds of each spring load is supported by the adjacent outside axle and one-third by one arm of the equalizer. Each journal of a given side of a truck, therefore, receives one-third of the total spring load on that side and furthermore the equalizer precludes the possibility of the springs receiving unequal loads on the same side of the truck. This feature affords extreme flexibility in the side members.

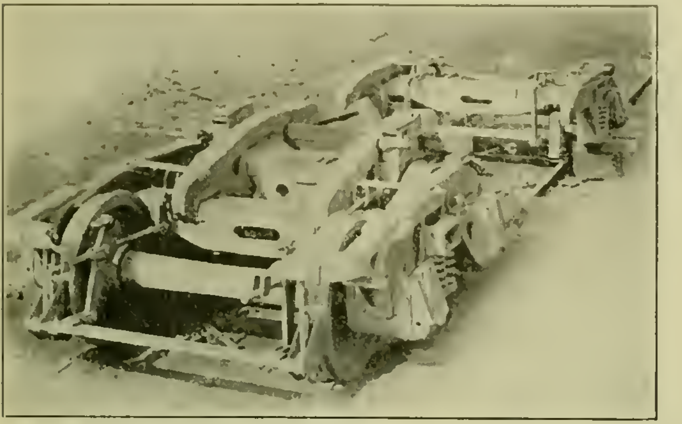


Fig. 2—Longitudinal Bolsters Raised and Four-Wheel Section of Truck Rolled Out

Maintenance and Inspection

In former designs of six-wheel trucks replacement of axles, particularly the middle axles, has been accomplished only by the use of special facilities such as drop pits, or overhead cranes. Replacement of bolsters required cutting away rivets and complete dismantling of the truck.

Where large numbers of cars with six-wheel trucks must be maintained in constant service, facilitating the routine work of upkeep is of great importance. The Buckeye truck in its present form is a remarkable advance in this respect. All the parts are of such size and are so disposed with relation to each other that light repairs such as changing bolsters, axles and springs are readily accomplished even in places where no special facilities are at hand other than those used in connection with four-wheel truck repairs.

The simple method employed in the removal of the middle pair of wheels is deserving of special mention. The two consecutive steps are shown in Figs. 2 and 3. After removing the bolts, *A*, Fig. 2, from the ends of the equalizer arm and the brake pin, *B*, the two longitudinal bolsters are disengaged from one transverse bolster by tilting them upward so that the truck may be separated as in Fig. 2. Then by placing jacks under the spring seats at *D*, Fig. 3, and removing the equalizer bolts at *F*, the center axle is relieved entirely of its load and can be rolled clear as shown in the illustration.

To facilitate replacement of the transverse bolster, the bolster opening in the frame in designed similar to that of a four-wheel truck frame. The spring seat casting, which carries the brake brackets for the inside brake beams, is separate from the frame. Hence, by jacking up the longitudinal bolsters and removing springs and spring seat castings, the transverse bolster may be replaced in a manner similar to that used with four-wheel trucks.

As will be noted from Fig. 4, the use of a separately constructed spring seat and brake hanger casting introduces another advantage, namely, that it permits of making all side frame castings identically alike. This is a distinct advantage, both in the manufacture of the trucks and in the upkeep of repair part stocks. As an aid to inspection, it is to be observed that all springs in the Buckeye truck are visible and arranged in groups of four in the bolster opening of the side frames as in four-wheel trucks.

Comparing the truck construction shown in the drawing with that shown in the photographs, it will be noted that the former illustrates the use of A. R. A. type journal boxes, also a different construction of end brake hanger. Trucks with these modifications are used only experimentally, the Virginian standard design in all other respects being as shown in the photographs.

Flexibility and Short Wheel Base

By reason of the side frame and bolster construction, the Buckeye truck retains all of the flexibility of the four-wheel truck. Besides providing vertical flexibility, the Buckeye type of equalizer makes possible the extremely short wheel base of 8 ft. 2 in. Due to the necessity of making the brake parts interchangeable with those of another type of truck of a longer wheel base, the wheel base on the Buckeye trucks on the Virginian cars was increased four inches and is therefore 8 ft. 6 in. as shown in the drawing. The clasp brake rigging used in the Buckeye trucks is suspended entirely from parts independent of the spring travel.

Safety of Detail Structures

A notable accomplishment in the Buckeye truck design is the avoidance of load carrying members subjected solely to tension. In the Buckeye trucks, the parts that carry the loads are so designed and assembled with relation to each other that they are not subjected to direct tension stresses: i. e., the parts perform the function of beams rather than that of hangers. From the foregoing it will be noted that prac-

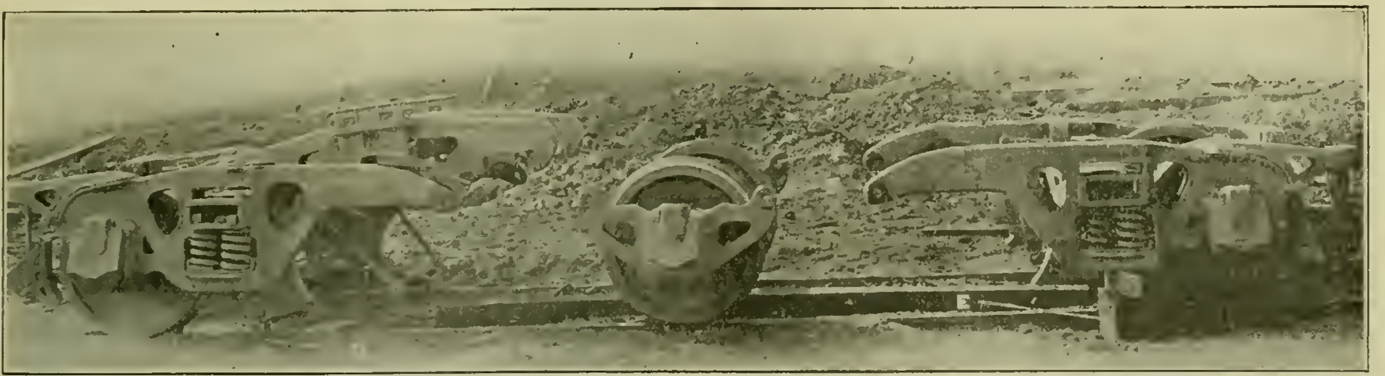


Fig. 3—Center Wheels Ready for Removal

tically all of the important fundamentals of the four-wheel truck have been observed in this six-wheel truck design.

Specification and Weights

The Buckeye trucks as used on the Virginian were designed for use with car bodies having either 12⅞ in. or 18½ in. center sill spacing and with truck centers of 36 ft. 1¾ in. The design conditions specified that the cars should operate successfully over tracks having a horizontal curvature of 20 deg. and a vertical curvature of 350 ft. radius. These conditions have been met with a safe margin as evidenced by experimental tests where cars negotiated curves of more than 30 deg. curvature.

The general specifications of the trucks are as follows:

Wheel base	8 ft. 6 in.
Center plate height (light car body)	27⅛ in.
Side bearing height (light car body)	42 11/16 in.
Center to center of side bearings	48 in.
Axles—A. R. A.	6 in. by 11 in.
Wheels	Rolled steel
Brake equipment	Clasp brake with vertical levers
Springs	Virginian No. 28 (Same as A. R. A. Class D, except 1 5/16 and 11/16 in. bars)
Free height of springs including caps	8½ in.
Solid height of springs	7 in.
Side bearings	Stucki
Brasses and wedges	A. R. A. standard

The total weight of the trucks per car is 37,000 lb., distributed as follows: cast steel parts, 14,500 lb.; brake material, 3,800 lb.; springs, 1,100 lb.; wheels and axles, 15,200 lb., and other material, 2,400 lb.

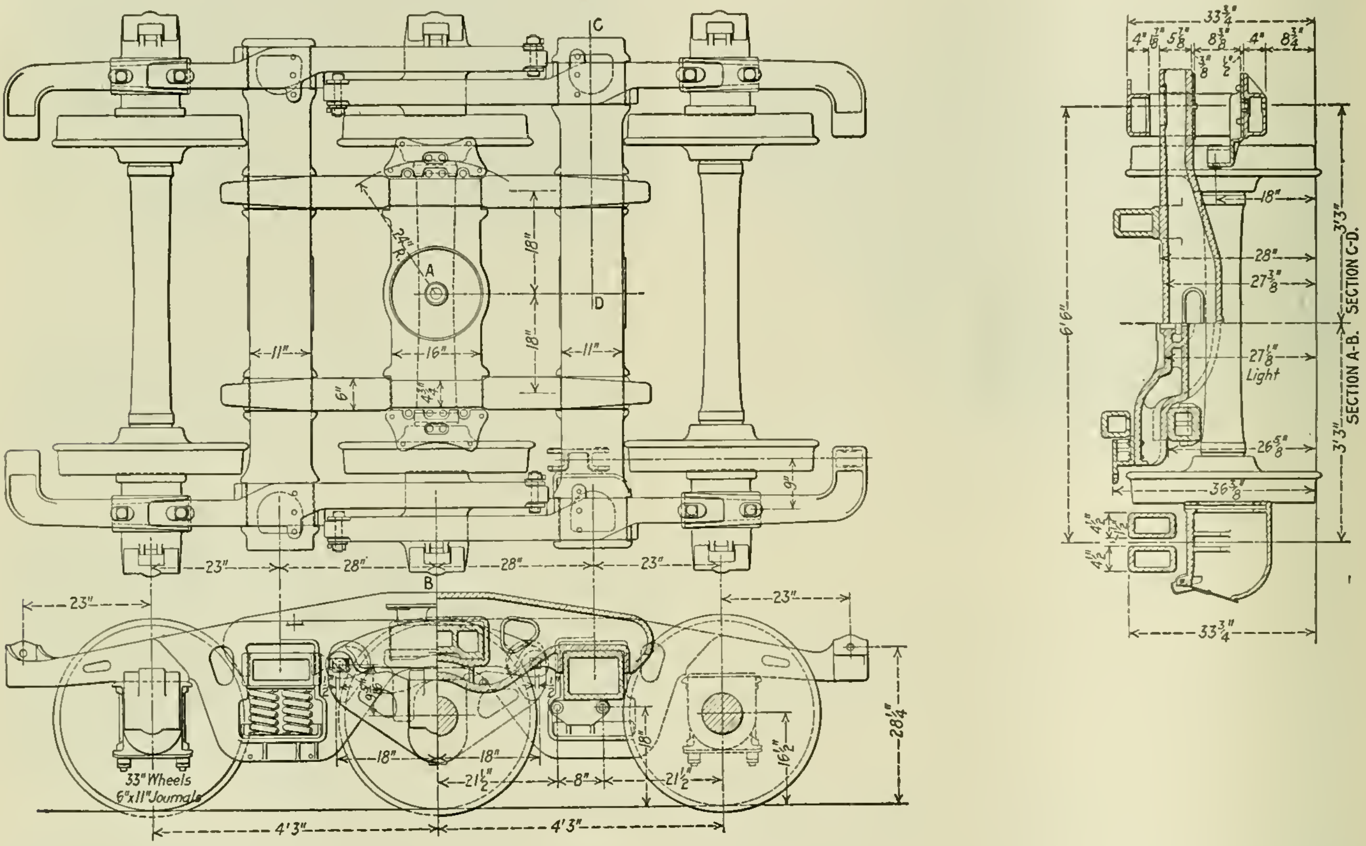


Fig. 4—Assembly of the Buckeye Six-Wheel Truck

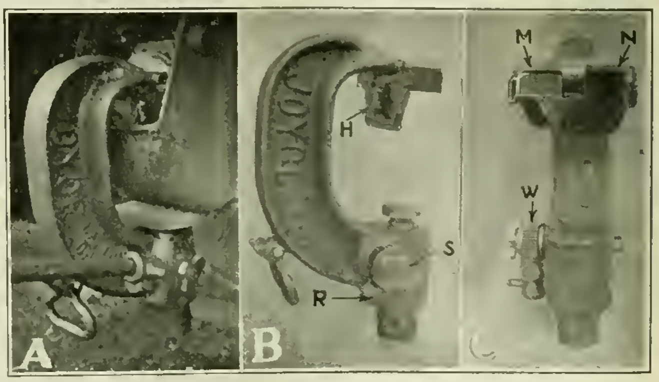
Universal Type Suspension Journal Jack

To facilitate the changing of car journal brasses the Joyce-Gridland Company, Dayton, Ohio, has added to its line of lifting jacks a new universal suspension journal jack, illustrated. This jack is called universal because only one size is required for use on any standard M.C.B. journal box. Simplicity and a minimum number of parts are features of the jack, which is provided with ball bearings throughout.

The principal advantage of the new jack and its method of use is shown at *A* in the illustration. It will be noted that the jack is applied over the journal and under the box and operation of the ratchet relieves the weight from the brass, allowing it to be taken out over the jack. This operation is quickly performed since there is no lost motion, and it is not necessary to spot a car in such a manner that the journal box will be over a tie. All blocking and jacking under the journal box is eliminated; also any arrangement to hold the wheel on the rail as the box is lifted.

Another important advantage results from the fact that it is impossible to run the new jack out under a load, since the open portion of the box will go up against the top of the jack and stop it. The old type of jack could be driven out beyond the safety limits of the screw and often dropped the load.

Referring to sections *B* and *C* of the illustration the construction and operation of the jack will be evident. Two intermeshing tooth-type jaws *M* and *N* are adjustable to-



Improved Type of Car Journal Jack

gether or apart by means of hand-wheel *H* to fit any size journal desired. These jaws fit on over the collar of the journal at such a point as not to interfere with the removal of brass or wedge. Ratchet *R*, in conjunction with the fine tooth ratchet wheel *W* operates the lifting screw and the leverage is such as to give ample power. A speeding button *S* hurries the action of the jack to the point of lift. It is stated that only a short lever is required to lift the heaviest loads and that the principal merit of the device is in the elimination of lost motion, a rise of from ½ in. to ¾ in. enabling the wedge and brass to be removed. The jack is light, weighing only 60 lb. and can be readily carried over a man's shoulder, as the frame is broad and flat.

It is stated that thorough tests in actual service were followed by several minor changes and improvements and that the jack is now ready for the market. In places where the average work of a brassing crew was 22 boxes a day, one man was able to brass 39 boxes the first day and 44 the second day. This work was all done by one man where two had previously been employed.

Pneumatic Crude Oil Flange Lubricator

THE question of flange lubrication to eliminate undue wear of flanges and rails is a serious one and a device designed to eliminate difficulty from this cause has been developed by the Hoofer Manufacturing Company, Chicago. In construction the device consists of a pneumatically operated crude oil lubricator (Fig. 1) of either four or six feed type which is installed above or below the running-board or secured to the locomotive frame at any convenient position for filling with oil. Air pressure for operating the discharge pistons is supplied from the brake system and a lever or gear controlled air valve (Fig. 2) is installed in the pipe at any convenient place. This valve is provided to control the supply of air pressure to the top sides of the oil discharge pistons. The air thus supplied acts to force the pistons downward into their respective oil cylinders in the bottom of the lubricator, thus discharging oil into oil pipes which lead to the wheels. There are small vents or passages through the caps on the tops of the oil discharge pistons, so that a small amount of air is free to pass through which acts as a means of conveying each charge of oil to the wheel flanges. In this manner measured quantities of oil are delivered at regular distances to an oil distributor (Fig. 3) at each wheel. The amount of oil discharged may be regulated by interchangeable nipples in the bottom of the lubricator, as these nipples are constructed with cylinders of various depths whereby any size may be replaced by another of the desired capacity.

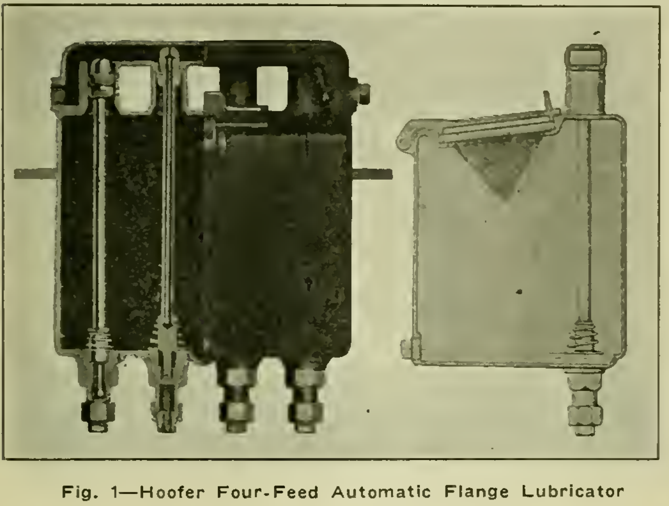


Fig. 1—Hoofer Four-Feed Automatic Flange Lubricator

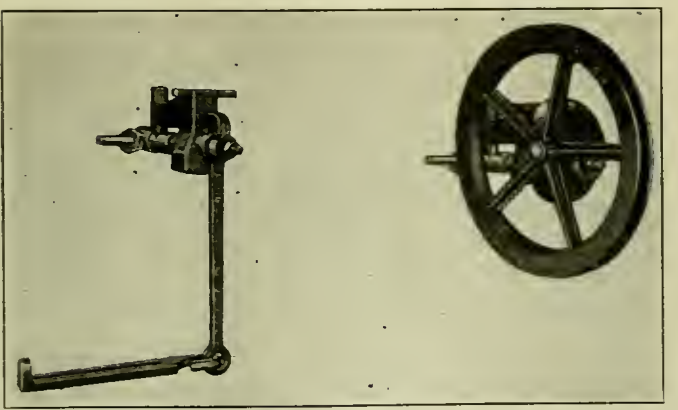


Fig. 2—Lever and Gear Operated Control Valves

The construction of the lubricator is simple, with few parts to get out of order. While the four-feed type is illustrated, the six-feed type is recommended for Atlantic or Pacific locomotives, for oiling the truck wheels also.

Two forms of air valve are illustrated in Fig. 2. The lever controlled air valve shown at the left is adapted for switch engines. It may be installed in the air supply pipes in any convenient place near the back of the engine where a connecting rod may be extended from its lever to the frame of the locomotive tender. By this means it is actuated by the relative swing between the engine and the tender when the locomotive is entering a curve, and oil is supplied to the flanges on curves only. The valve control mechanism is so constructed that when the lever is moved either way the valve opens for an instant and automatically closes when a pressure of 50 lb. is attained in the air cylinders of the lubricator.

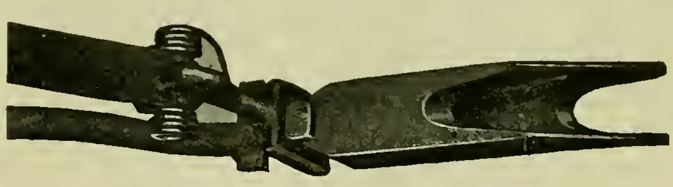


Fig. 3—Device for Distributing Oil to the Flange

The gear controlled air valve, shown at the right in Fig. 2, is generally adopted for locomotives in road service. It may be installed in the air supply pipes in any convenient place where a coil spring belt may be operated over the sheave of the valve and the axle of the locomotive. By this means it is actuated at regular distances traveled, and oil is supplied to the flanges at regular intervals. The valve is opened by the gear, but automatically closes when a pressure of 50 lb. has been obtained in the air cylinders.

Proper oil distribution is most essential to successful flange lubrication and the distributor shoe, shown in Fig. 3, has been designed especially for this purpose. The outlet passage for the oil is constantly maintained in contact with that side of the flange which wears against the rail, and the wearing action of the wheel flange against this outlet passage causes it to fit the flange closely. The oil is thus applied in a thin film upon the particular portion of flange where it is most needed. Owing to centrifugal force a revolving wheel tends to throw off the oil. This difficulty is completely overcome by the pneumatic feature of delivering the oil through the oil passages and forcing it into the crevice of the wheel flange by a current of air under pressure. The oil distributor consists of a cast iron hollow shoe through which an oil passage extends parallel with and partially within the wall of the shoe, nearest the tread side. These shoes are secured to hangers by tapered keys which may be removed with a hammer when necessary to renew the shoes. The hanger spring holds the oil distributor in a well-balanced position over the flange at all times.

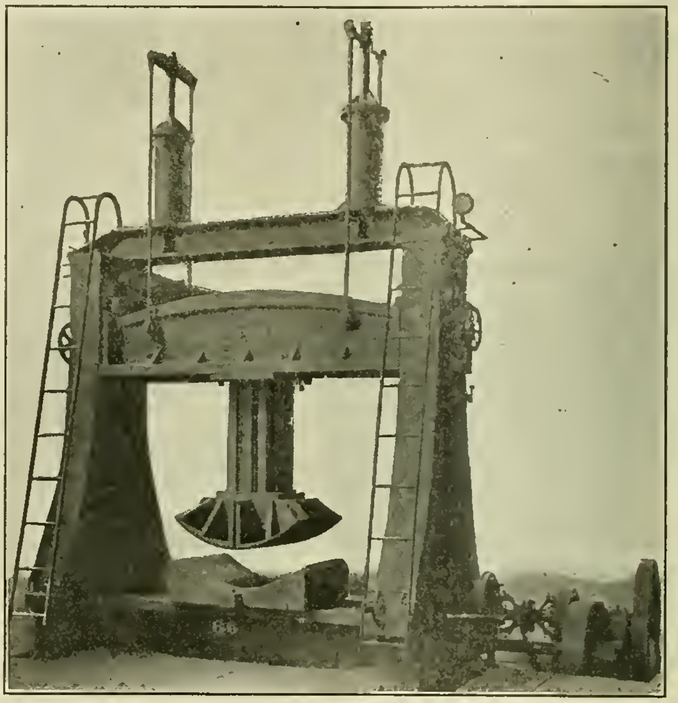
Vertical Bulldozer for Steel Car Work

THE principal features of a new vertical bulldozer, made by the Beatty Machine & Mfg. Co., Hammond, Ind., are its simplicity of construction and the location of driving parts. The main shaft is mounted through the lower bed instead of overhead, and the main side gears are enclosed in a box type housing, with all intermediate gears fully enclosed. Clutches and high-speed bearings are easily accessible.

The general construction includes a heavy bed or table casting with main shaft, side gears and connecting rod to the crosshead. A 4 in. vertical adjustment connection at each end of the crosshead eliminates loss of time in changing dies. The crosshead is fitted at both ends with bronze tapered gibs for adjustment in case of wear to the slides. Air cylinders are used for counter-balancing the weight of the ram. All gearing is of cast steel with cut teeth. The machine is also fitted with forward and reverse clutches which permit reversal at any point of the stroke. Arrangements for either belt or direct connected motor drive can be made.

The vertical bulldozer is especially adapted to steel car and car repair work for the pressing and forming of such parts as diaphragms, stakes, roof carlines, end sills and a general line of sheet metal plate and bar parts. The dies which are attached to the machine illustrated are used for forming plates in tank car tanks, giving the plate full radius, overcoming the difficulty experienced in rolling these plates and eliminating the straight edge at each side.

The machine is built in sizes up to and including 500 tons ram pressure. The distance between housings ranges from 8 to 12 ft.; vertical die space with stroke down and adjustment center, 24 to 72 in.; stroke, 18 to 24 in.; stroke per minute (small size, 16), large size, 8 to 10. The smallest size weighs approximately 24,000 and the largest 120,000 lb.



Beatty Vertical Bulldozer

Clutch Tap and Die Holder of Simple Design

SIMPLICITY and relatively few parts are features of a new clutch tap and die holder developed by the Warner & Swasey Company, Cleveland, Ohio, and illustrated in Fig. 1. This clutch has been patented and because of its general adaptability should prove extremely useful in railroad machine shops. Only eight parts are used in the construction of this tool, as shown in Fig. 2, and all the principles of an older model embodying 23 parts are incorporated. Either right or left-hand dies or taps can be held in the new holder which thus becomes two tools in one. To change from right to left, a screw-driver is the only tool required. After releasing the small tightening screw, the rest can easily be done with the hands. The only difference in the tool when used for right or left-hand work is in the position of the pawl. To change from one to the other, the pawl it turned half way around in its hole, a small pin holding the pawl in whichever position it is placed.

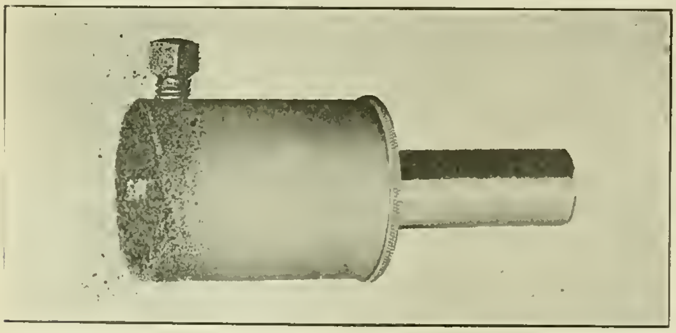


Fig. 1—Simplified Warner & Swasey Clutch Tap and Die Holder

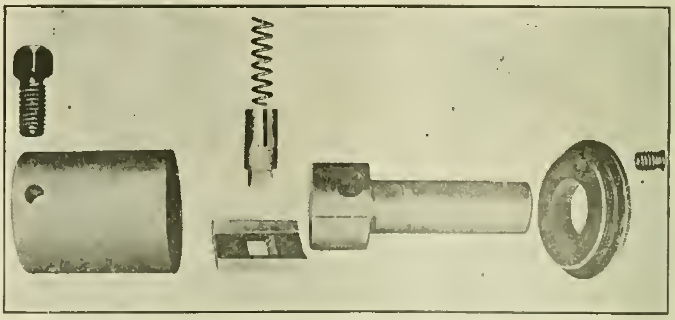
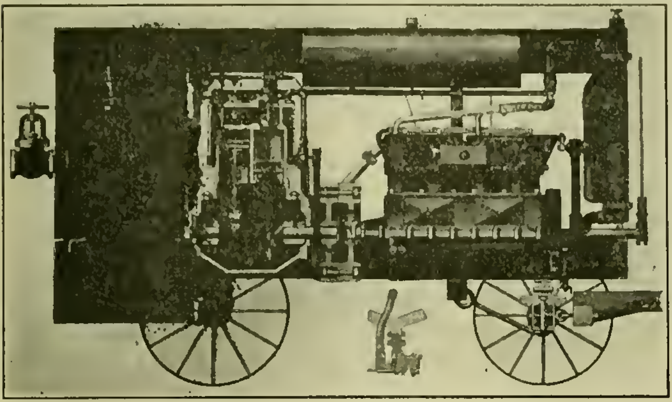


Fig. 2—View Showing Parts of Clutch Tap and Die Holder

When threading on a turret lathe, the pawl holds the tool rigid by a metal to metal contact, until the turret stop is reached. Then the head moves forward on the work, pulls the cam over the pawl and releases the head, thus allowing it to revolve freely. The spring cushions the pawl so that the release is without jar and practically noiseless. The material in each part has been carefully selected and designed to stand the work required of it. Arrangements have been made for the easy cleaning and oiling of the tool which insures reliability of operation and long life. This clutch tap and die holder is valuable for use in machine shops, particularly on brass work.

Gasoline-Driven Portable Air Compressor

Supplementing its line of portable air compressors, the Chicago Pneumatic Tool Company, New York, announces a new gasoline-driven, portable air compressor which is said to combine large capacity with light weight.



Portable Air Compressor with Capacity of 128 Cu. Ft. of Free Air per Minute

The compressor is of the two-cylinder, single-acting, vertical type with the cylinders cast en bloc and entirely water-jacketed. The gasoline engine is of the tractor-marine, four-stroke cycle, four-cylinder type, the compressor and engine-shaft being connected by a flexible coupling which serves also as a flywheel.

The crank case is completely enclosed and is provided with large openings for inspection, cleaning or adjustment. The bearings, which are cast integral with the crank case, are accessible and can be easily adjusted by means of liners. Baffles are provided to prevent an excess of oil from working above the pistons into the cylinders.

A pneumatic throttle working automatically in conjunction with the engine governor and the differential unloader of the compressor, throttles down the speed of the engine when the compressor is running unloaded. By this means, it is said that a marked saving of both fuel and lubricant is effected. The compressor illustrated has a capacity of 128 cu. ft. of free air per min. and delivers this air at a pressure of 100 lb. per sq. in.

Both compressor and engine are cooled by a system designed to be positive and reliable. Two centrifugal circulating water pumps, one driven from the magneto shaft and the other belted to the compressor crank-shaft, force water through jackets of liberal size and through a large radiator, which is cooled by a powerful fan belted directly to the engine shaft. Oil from the crank case of the compressor is picked up by an oil thrower attached to the connecting rod and is thrown into channels which lead to all the bearings. Some of this oil is carried by the pistons into the cylinders, which are thus thoroughly lubricated.

A receiver of large capacity is mounted directly on the truck and is equipped with safety valve, drain valve, discharge valve and pressure gage. The entire equipment is firmly mounted upon an all-steel truck, having a steel plate canopy top and sheet steel sides which completely enclose the outfit. The sides can be locked in place.

Air-Operated Hoist of Novel Design

An air-operated hoist embodying several novel features in design has been developed recently by the Sullivan Machinery Company, Chicago. This hoist was designed to meet the demand for a small, compact and powerful portable engine, for general hoisting work within its range. It may be mounted on a cross-bar or column, bolted to a timber, or fastened to the wall or floor for miscellaneous hoisting or hauling jobs. Fig. 1 shows the device hauling a box car to the shipping door. The capacity of the hoist is 1,500 lb. dead load, lifted vertically at 100 ft. per min., using an air pressure of 80 lb. per sq. in. The device is known as the Turbinair, weighs 285 lb. and the drum will accommodate a maximum of 500 ft. of 5/ 16 in. wire rope cable.

Simplicity is an important feature of the device which consists of a cylindrical drum, mounted on a steel frame and completely enclosing the operating mechanism. Two cylindrical rotors, one of which is shown in Fig. 2, are provided with right and left-hand helical flutes or vanes converging to a spur tooth in the center. The two rotors mesh together as they revolve under the influence of the incoming air. Reduction gearing is arranged to drive the drum shell.

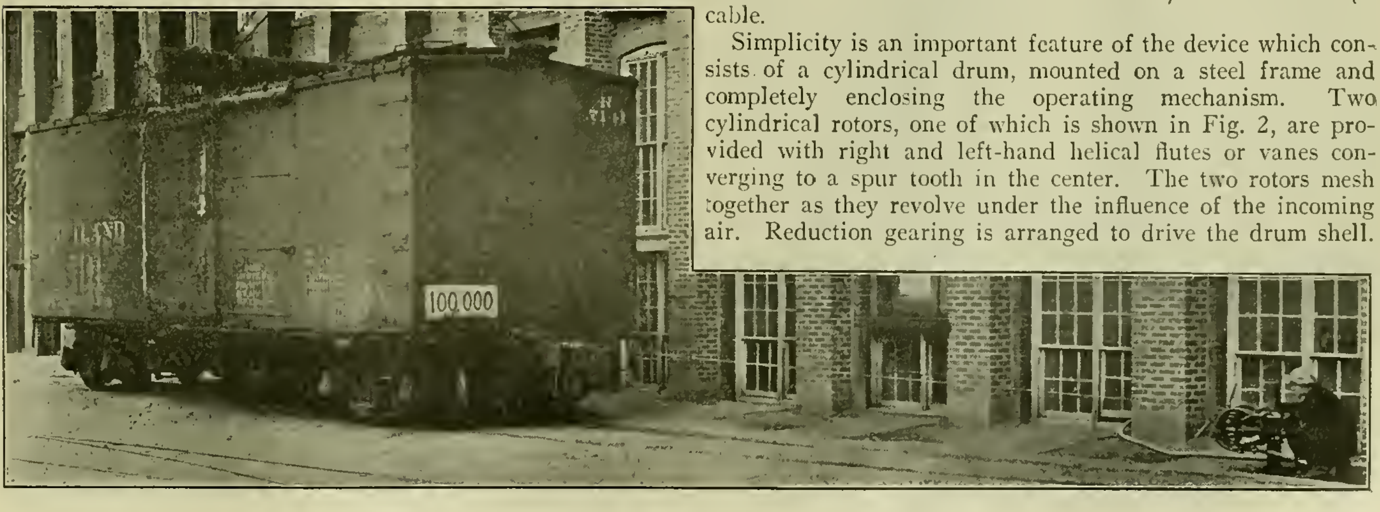


Fig. 1—Turbinair Hoist Arranged for Shifting Freight Cars

This motor is said to develop a high starting torque, to be economical in the development of power, as it uses the air expansively and to have shown long life and sustained efficiency in service.

The hoist is provided with a friction clutch and brake and when both handles are released the rope may be pulled freely from the drum. The friction clutch may be locked in position and the load raised or lowered, being controlled entirely by the throttle valve. The brake is of the band type and is of sufficient strength to hold any load within the capacity of the hoist. It works smoothly, thus putting no unnecessary stress on either the mechanism or the rope.

Air is admitted at the axis of the drum through a hollow shaft, and the motor revolves with the drum. Ball bearings are employed and all mechanism is totally enclosed, being well lubricated. The rotors are lubricated by an automatic oiler. The hoist is quiet in operation, therefore, and does not interfere with signals and instructions being transmitted. The machine is recommended for any duty for which portable column air hoists are generally used. The power developed is 4½ h. p.

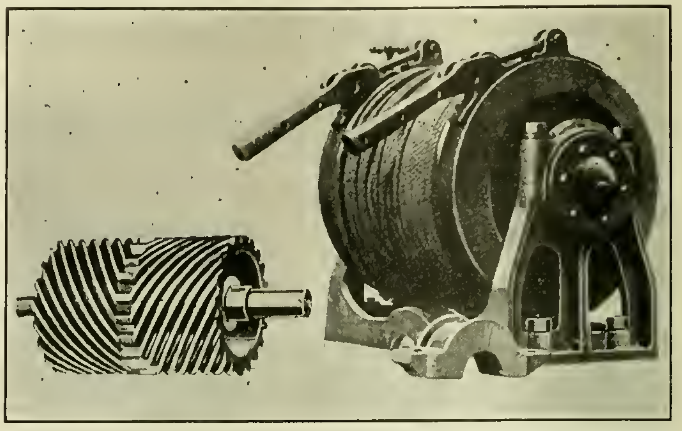
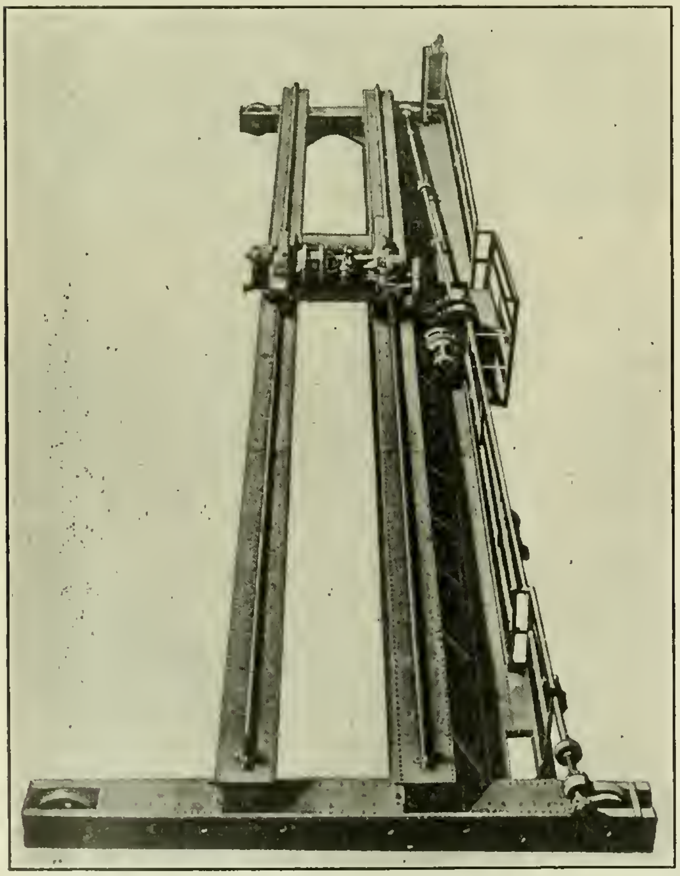


Fig. 2—View of One of the Rotors and Assembled Hoist

Driving Mechanism for Roundhouse Crane

A NEW ten-ton overhead roundhouse crane, involving two features of particular interest, has been installed recently by the Champion Engineering Company, Kenton, Ohio. The first of these features is the construction of the driving mechanism in such a way as to enable the truck supporting wheels to be of the same diameter, the parts of the driving mechanism being interchangeable and designed to provide positive, reliable operation. The second unusual feature is an arrangement for correcting the tendency of a crane to get out of square. This is applicable not only to the roundhouse crane illustrated but to all electric traveling cranes of the overhead type. Such cranes get "out of square" with the runways, particularly on long spans, due to various causes; one of the driving wheels may wear faster or have less traction than the mating one at the opposite end of the truck; the truck may not have been placed squarely on the girders in the first place; a sudden stop after traveling at high speed with the crane fully loaded at one end also tends to get the crane out of square. In the crane, illustrated herewith, provision has been made for the rectification of this condition.



Champion 10-Ton Roundhouse Crane

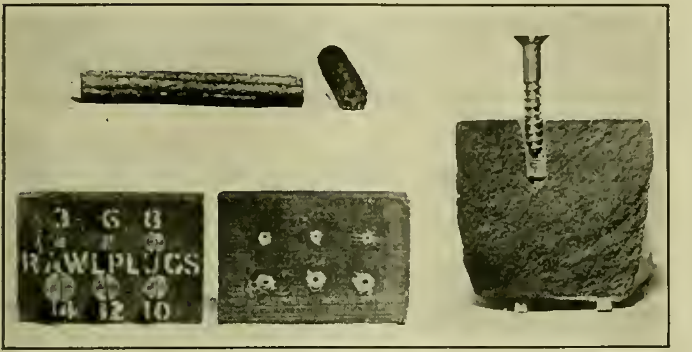
In order to drive the crane properly around a curved structure, all supporting wheels being of the same diameter, the mechanism shown in the illustration has been installed. It will be noticed that the electric motor is mounted in the middle of the span and is provided with a shaft on which are keyed two pinions of different diameters. These pinions mesh with two gears keyed to sections of the drive shaft, one section extending to the inner radius and the other to the outer radius. The diameters of the two driving pinions and gears are such as to revolve the supporting truck wheels at the proper porportional speeds and maintain the crane in the correct radial position.

In order to reline the crane, should it become out of square, a clutch has been placed between the two driving pinions so that either pinion may be operated independently of the other. When the crane becomes out of square, therefore, this clutch is used to turn one pinion slightly while the other is still and place the crane back in a radial position. When the crane is properly alined the clutch is re-engaged, both pinions being operated at the same speed by the motor shaft. This method of drive can be applied to cranes operating on straight tracks if the gears are properly proportioned and the clutch normally engaged.

Should a crane equipped with this form of drive become out of square to such an extent that the truck wheel flanges are binding on the track, causing the usual difficulties and troubles, the truck can be readily made square by means of the clutch between the two driving pinions. The entire design of the crane and driving mechanism has been made with a view to providing positive and reliable operation. In this way many locomotive delays are prevented and the work of maintaining running repairs is greatly facilitated because of the ease in moving heavy parts from one track or department to another.

Making Screws Hold in Any Material

THERE has recently been placed on the market a device known as the Rawlplug, which permits fixing an ordinary screw into any kind of material so that it will hold permanently. By its use screws may be made to hold in metal, plaster, brick, concrete, slate, glass, or, in fact, any substance. The Rawlplug is especially advantageous in railroad work in connection with maintenance, signal and interlocking systems and for the original installation of interior trimming and fixtures for both steel and wooden coaches. Its use solves the problem of replacing screws in repair work on the interior of cars, as an old screw can be removed and again put in place permanently in the same hole by simply inserting a Rawlplug before placing the screw. The use of Rawlplugs in metal eliminates the need for tapping and does away with tapping costs.



A Rawlplug; Several Sizes in Place, with and without Screws; Cross-section Showing Plug Expanded and Threads Cut by Screw.

Rawlplugs are hollow tubes of stiffened, longitudinal strands of jute fibre, so cemented that once in place they do not crumble or pulp and are unaffected by moisture or temperature changes. They are installed by first making a hole with any common drilling tool or with the Rawlplug tool in the material into which the screw is to be fixed, this hole being the proper size to receive the Rawlplug with a sliding fit. The plug is inserted into the hole and as the screw is turned home in the plug, the fibre strands expand and enter every minute pore of the material, practically becoming an integral part of it. The screw forms a thread in the fibre plug. The threads hold securely, but permit withdrawing and reinserting the screw in the usual manner whenever desired.

Tests conducted under actual working conditions showed that Rawlplugs withstood a direct pull, expressed in pounds, varying from 150 in plaster up to 600 in iron, or 1,250 in common brick for a number 14, 2 in. screw. These results were obtained by a direct pull and the plugs withstood a correspondingly greater stress in every case for an indirect pull.

Rawlplugs offer an economical method of fixing screws permanently. It is stated that their low cost will save about one-half the initial expense and, because they require small holes, will save about five-sixths the time necessary to drill and fix in place. They give a neat finished appearance as the head of the screw entirely covers the hole. Other advantages of this device include the ability to absorb and resist vibration and the fact that the plugs do not fracture material when expanded. They can be successfully used in conjunction with ordinary wire nails.

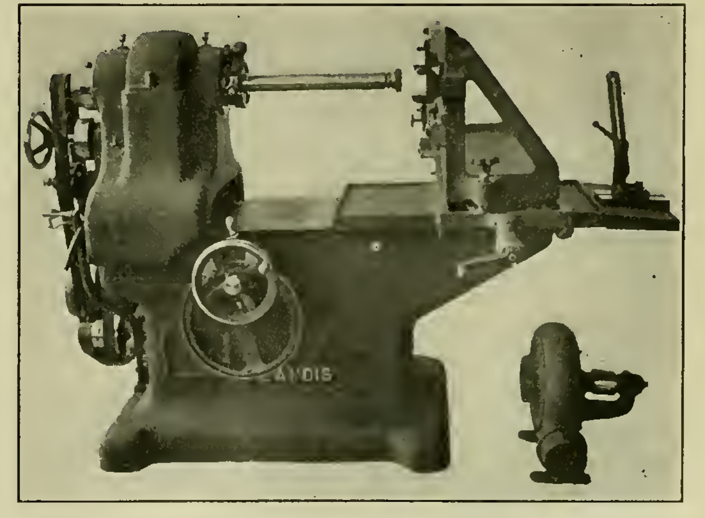
Rawlplugs are made in sizes to receive all screws from a number 1 to a number 32 and are furnished in ½ in., ⅝ in., ¾ in., 1 in., 1½ in. and 2 in. lengths. For convenience, tools for forming holes for Rawlplugs are made in sizes to correspond with plug and screw sizes. For example, a number 8 tool makes a hole of the proper size to receive a number 8 plug and a number 8 screw. Any type of drill may be used, however, for making the holes.

Rawlplugs are packed in boxes of 100 plugs of any one or assorted sizes. There are also various complete kits which include plugs, screws and tools. This product is manufactured by the Rawlplug Company, New York, which is represented in the railroad field by the Universal Packing & Service Company, Chicago.

Internal Grinder for Irregular Parts

AN internal grinding machine has been developed recently by the Landis Tool Company, Waynesboro, Pa., for regrinding automobile cylinders, but it is also adapted to the internal grinding of miscellaneous irregular machine parts in railroad and other shops. The center of rotation of the grinding wheel spindle is 10 in. above the top of the work carriage so that large castings may be easily handled with no extra or special fixtures. The spindle regularly furnished will grind 15 in. deep and eccentric adjustment of the spindle, ranging from 1/16 in. to 1 1/16 in., permits grinding holes as large as 5⅝ in. in diameter with standard 3½-in. grinding wheels. Two spindle driving pulleys are furnished to give the correct peripheral speed of approximately 6,500 ft. per min. with 3½ in. and 4½ in. diameter grinding wheels. Extra wheel spindles and sleeves for grinding 20 in. and 22 in. deep, or for diameters larger than 6 in., can be furnished if desired.

The work carrying fixture is an open angle plate design with two adjustable work clamping bars. The work to be ground is securely clamped to the bars by two heavy machine clamps of ample capacity. A distinctive feature of this fixture is the arrangement for quickly and accurately alining the work in vertical position to the center of spindle rotation. A centering bar fits neatly into two slots milled in the frame of the work carrying fixture and carries two adjustable bear-



Landis Internal Grinding Machine

ing brackets. Before clamping the work onto the machine, these centering brackets are inserted into the hole to be ground to ascertain the exact size. They are set to this dimension and the work is then lifted to the machine and fitted over the brackets of the alining bar, where it is securely clamped to the work carrying fixture. After it is clamped in position, this alining bar is removed. If the work is not absolutely alined, minor adjustments can be made by a screw in front of the fixture which permits it to be raised or lowered as required.

The work carriage has a cross movement of 27½ in. and is mounted on a traveling carriage which operates on a flat and a dovetailed guide. Lubrication of these guides is assured by rollers running in pockets filled with oil. Traverse movement of the work carriage is automatic and reversing action is obtained by two self-locking adjustable dogs. These dogs are accurate in their functioning, which permits grinding close to shoulders. The speed of traverse is constant at 10 in. per min. and is independent of all other mechanisms. The maximum movement is 31½ in. The outside eccentric spindle which carries the wheel spindle eccentric sleeve runs in two wide-tapped bearings, and liners afford a correct running fit. The lower half of the bearing is cast as a part of the head, which makes it rigid and practically eliminates vibration at this point. The eccentric adjustment or cutting feed is obtained by the relative position of the two eccentric sleeves, one within the other. Feed is obtained by a sensitive mechanism mounted on the end of the outer sleeve. Provision is also made for the application of a crank for rapidly changing from one size hole to another.

The machine is arranged for either direct motor drive or for lineshaft drive through a small overhead countershaft. If motor drive is used, a 3-hp. motor operating at 1,150 r.p.m. furnishes ample power. If driving from a countershaft, a 3½-in. belt is used. The floor space occupied is 88 in. by 88 in. and the net weight of the machine is approximately 2,900 lb.

Floating Holder Corrects Spindle Misalinement

In order to correct spindle misalinement in reaming, tapping, counterboring, and various other operations, the McCrosky Tool Corporation, Meadville, Pa., has recently developed the floating holder illustrated. Spindle misalinement may be either angular or parallel and this holder is designed to make corrections for both. The second important feature of this holder is its design to eliminate friction or strain preventing freedom of action of the cutting tool.

Referring to Fig. 1 which shows the holder disassembled, its construction and operation will be evident. It is composed of a driving member *A*, an intermediate floating member *B*, and a driven member *C*. The driving member is made in different styles and sizes to fit various spindles in which the holder may be used, three of these being shown in Fig. 2. The driven member is also furnished in different styles and sizes to take various reamers, taps or other tools. Two lugs on the driving member interlock with two similar lugs on the driven member. Four hardened rollers *D* operate between these lugs and the intermediate floating member to remove all friction from the drive. In the center of the floating member is a hole containing a hardened steel ball *E*. This ball has a diameter greater than the thickness of the floating member and therefore bears against both the driving and driven members *A* and *C* taking the entire thrust of the cuts.

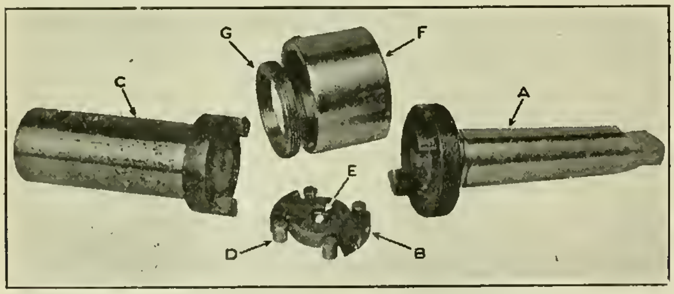


Fig. 1—Disassembled View of McCrosky Floating Holder

The housing *F*, which encloses the floating member, screws on to the driving member *A*. It has an adjusting collar which bears against *C* and regulates the amount of play. When this holder is used horizontally an adjustable spring support bearing against the driven member is added to counteract the weight of the tool shank.

It is evident from a consideration of the above that the rollers take the driving torque and in conjunction with the center ball permit movement in all directions practically without friction. This makes it possible for instance to ream a hole, true to size, straight and round, in spite of serious spindle misalinement. The holder is adaptable to use on drill presses, turret lathes, automatics, boring mills, engine lathes, and other similar machines.

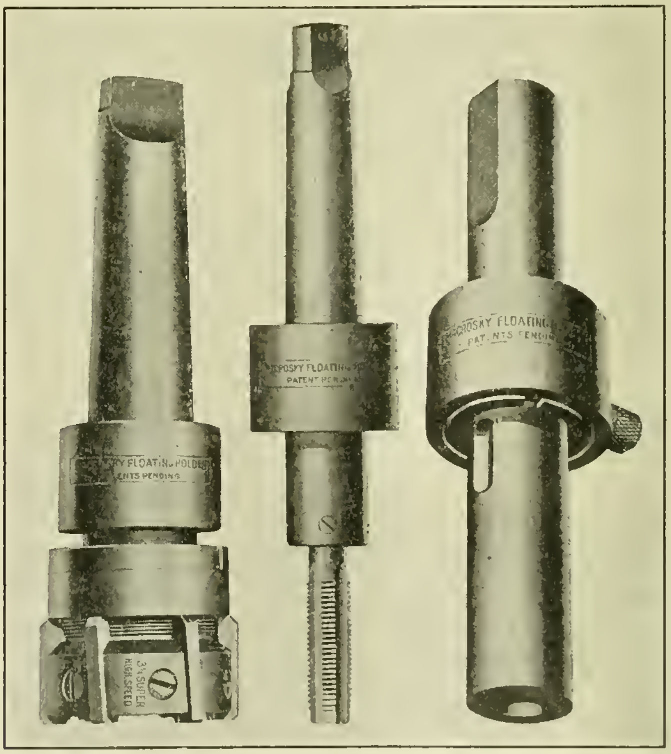


Fig. 2—Floating Holders for Reamers, Taps and Morse Taper Tools

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The Polish railways, which suffered heavily during the war, have been systematically improved since they were taken over by the Polish Government. The rolling stock is being gradually repaired and large additions have been made, due to the decision of the Inter-Allied Commission, which recognized Poland's right to the return of 481 locomotives that were taken by the Germans during their occupation. Of these 182 are already in service again.

Railway Mechanical Engineer

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WE GUARANTEE, that of this issue 8,850 copies were printed; that of these 8.850 copies 7.763 were mailed to regular paid subscribers: 7 were provided for counter and news company sales, 245 were mailed to advertisers; 32 were mailed to employees and correspondents and 803 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 76,350, an average of 8,544 a week.

The *Railway Mechanical Engineer* is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.)

The Union Pacific, on July 17, re-employed 1,500 men on its Mountain division who had been laid off with the slump in business.

The Chicago, Burlington & Quincy, on July 1, put on 1,500 workmen to repair grain and coal cars, according to E. P. Bracken, vice-president in charge of operation, to make ready for the expected heavy movement of these commodities.

About 2,000 shopmen of the Delaware & Hudson resumed work on July 5, after a general suspension of work lasting six weeks. Certain shops on the Baltimore & Ohio on the same day took back about 3,600 shopmen who had been furloughed for three weeks or more. It is said that at the Mount Clare shops of the Baltimore & Ohio, in Baltimore, the forces now aggregate about two-thirds the normal number.

An erroneous statement occurs in the sixth sentence of an article describing the Minich safety hand brake, published on page 1464 of the June *Railway Mechanical Engineer.* The sentence should read, "The usual brake chain is eliminated, being replaced by a connecting bar attached to the brake rod (or air brake lever on hopper cars)."

Locomotives

The National Railways of Mexico have ordered from the American Locomotive Company 20 Consolidation type locomotives, with a total weight in working order of 314,000 lb., and 7 Mikado type locomotives, with a total weight in working order of 440,000 lb.

Freight Cars

The Wabash has given an order to the Western Steel Car & Foundry Company for making repairs to 300 steel hopper cars of 40 tons' capacity.

The Western Pacific has ordered 25 30-yard extension side dump cars, of 50 tons' capacity, from the Clark Car Company, Pittsburgh, Pa.

The Illinois Central has contracted for the repair of 400 gondola cars with the Haskell & Barker Car Company.

Contracts for Car Repairs

The Illinois Central has awarded a contract to the General American Car Company, for rebuilding 600 all-steel gondola cars.

The Chicago & Illinois Midland has given a contract to the General American Car Company, for rebuilding 725 composite gondola cars.

The Missouri Pacific will have repairs made to 500 wooden box cars by the Sheffield Car Company.

Shop Construction

The Atchison, Topeka & Santa Fe is installing a new 120 ft. turntable at Winslow, Ariz., with company forces.

A New Technical Magazine

"Management Engineering" is the title of a new monthly publication issued by the Ronald Press, New York. Its contents are devoted to a discussion of the problems of management and production, the object as stated in the first issue being "to help executives better to discharge their duties in preparing, organizing and directing industry to secure maximum production." L. P. Alford is editor of "Management Engineering" and E. W. Tree, associate editor. Mr. Alford was formerly editor of the American Machinist and of Industrial Management. He is a vice-president of the American Society of Mechanical Engineers and chairman of the Management Division of that society.

Krupps' Output

Recent visitors in Germany report that Krupps is working to capacity in its locomotive and car shops. Their output at present is 20 locomotives per month, and the one thousandth freight car has recently been completed. This company is busy on locomotives for Russia and has a contract for tires for Russian locomotives. It is reported that the Prussian State Railways has a financial interest in the locomotive and car division of Krupps.

Roads Urged to Purchase Coal

Chairman Cuyler, of the Association of Railway Executives, has written to Chairman Clark, of the Interstate Commerce Commission, saying that his letter urging the railroads to purchase reserve supplies of coal as early as possible was read at a meeting of the member roads of the association in New York on July 1, and the chairman was instructed to transmit it to all roads with the request that they comply with the request of the commission in so far as it may be practicable. Mr. Cuyler said it was also ascertained that a very considerable number of roads had already made liberal purchases of coal.

Alcohol Locomotives in Brazil

In the vicinity of Pernambuco, Brazil, according to Consul C. R. Cameron, are some 80 sugar factories which operate approximately 800 miles of railways of from .75 meter to 1 meter gage. At the present time wood is the principal fuel but the supply of this fuel is not great and considerable interest is being manifest in the substitution of alcohol which can be manufactured in large quantities as a sugar by-product. The current price of alcohol, says Consul Cameron, is 22 cents a gallon, although the cost of production is much less. Mr. Cameron is impressed, consequently, with the opportunities in this section for American concerns manufacturing locomotives using alcohol as a fuel.

Salary Reductions on the Baltimore & Ohio

Coincident with the wage reductions for employees which went into effect on July 1, the Baltimore & Ohio also reduced "in like manner the compensation of those general, division and other officers and monthly employees who in the light of the higher cost of living were granted increases in their compensation at or since May 1, 1920," according to an announcement made on July 18. The announcement continued: "While the wages of such officers and employees do not come under the decision of the Labor Board, it was deemed necessary, because of the general conditions which so adversely affect the revenues of transportation companies, that such action be taken, notwithstanding it is recognized that during the period of inflation the officers did not receive increases in their salaries at the time or of the extent generally granted to many classes of officers and employees of industrial organizations nor in proportion to the increases granted from time to time to other classes of railroad employees generally."

Traveling Engineers' Convention Postponed

The Executive Committee of the Traveling Engineers' Association has announced that the annual convention, scheduled to be held at the Hotel Sherman, Chicago, on September 6-9, 1921, has been deferred. There will be a business meeting instead at the same hotel, commencing Tuesday, September 6, at which reports on the following subjects will be considered: Distribution of Power and Its Effect on Operating Costs; Recommended Practice for Conservation of Locomotive Appurtenances and Supplies; What Are the Advantages of Self-Adjusting Wedges, the Feed-water Heater and Devices for Increasing the Tractive Power of the Locomotive in Starting and at Slow Speed? The Best Method of Operating Stoker-fired Locomotives to Obtain the Greatest Efficiency at the Least Expense; A Comprehensive Standard Method of Employing, Educating and Examining Engineers and Firemen; Operation and Maintenance of Oil-burning Engines; Revision of Progressive Examination for Firemen for Promotion and New Men for Employment; Committees on Subjects, Constitution and By-laws and Arrangements. All other committees are asked to attend and be ready to submit their reports.

Hearing on Pennsylvania Locomotive Repairs

Oral arguments before the Interstate Commerce Commission at Washington on June 20, on the question whether the Pennsylvania caused 200 of its locomotives to be repaired at the shops of the Baldwin Locomotive Works in 1920 in disregard of efficient and economical management, resulted in a complicated statistical controversy as to whether the Pennsylvania showed wise management in making this contract instead of repairing the locomotives at its own shops. However, it remained for members of the commission to bring out by questions why so little had been put into the record at the previous hearings before an examiner bearing on the charges made by the International Association of Machinists that the repair contract was made for ulterior purposes to transfer money from the Pennsylvania Railroad, to be collected from the United States Government in the form of a guaranty, and into the treasury of an outside company for the profit of the banking combine said to control the railroads. The commissioners' questions on this point merely brought out that it was simpler to make such charges than it was to attempt to prove them and the commission was left to assume the evidence of a gigantic conspiracy which has been used so extensively as publicity material.

In reply to questions by Commissioner Lewis, R. B. Gregg, who appeared as attorney for the machinists' union, said that his organization would have objected to the contract even if the Pennsylvania had paid no more than the cost in its own shops, on the ground that it caused unemployment among the railroad shop men, although it had developed that the laying off of large numbers of Pennsylvania shop men had not taken place until several months after the letting of the contract and after business had begun to fall off in the latter part of the year.

Representatives of the railroad stated that the outside repairs were necessary because the road's shops were operated to capacity during the period while the Baldwin Locomotive Works was overhauling these engines. The traffic was so heavy that even with this power, it was impossible to meet the demands of service. It was also shown that the guaranty had not placed the burden for extravagant repairs on the government. The representatives of the machinists' union failed to show that the management has deliberately tried to cause unemployment, or that the Baldwin Locomotive Works made any undue profit. The fact was brought out in the testimony that the company lost money on the first part of the contract.

MEETINGS AND CONVENTIONS

The *Chief Interchange Car Inspectors' and Car Foremen's Association* convention for this year has been postponed.

The *American Railway Tool Foremen's Association* convention which was to have been held at the Hotel Sherman, Chicago, on August 9, 10 and 11, has been postponed.

The *International Railroad Master Blacksmiths' Association* convention which was to have been held at the Hotel Sherman, Chicago, on August 16, 17 and 18, has been postponed.

The *International Railway General Foremen's Association* has decided to cancel its 1921 convention which was to have been held September 12, 13, 14 and 15 at the Hotel Sherman, Chicago, owing to the financial stress and serious business conditions.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

Division V—Equipment Painting Division.—V. R. Hawthorne, Chicago.

American Railway Association, Division VI—Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamlin Ave., Chicago. Convention September 12-14, Hotel Sherman, Chicago, Ill.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Society for Steel Treating.—W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention September 19-24, Indianapolis, Ind.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Meeting second Tuesday of each month except June, July and August, at Windsor Hotel, Montreal.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Meeting second Monday in month, except June, July and August, New Morrison Hotel, Chicago, Ill.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 95 Liberty St., New York, N. Y.

Chief Interchange Car Inspectors and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill. Convention postponed.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Meeting second Tuesday of February, May, September and November, at Hotel Sinton, Cincinnati.

Dixie Air Brake Club.—E. F. O'Connor, 10 West Grace St., Richmond, Va.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 715 Clarke Ave., Detroit, Mich. Convention postponed.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn. Convention postponed.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York, N. Y.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Meeting second Tuesday of each month, except June, July, August and September.

New York Railroad Club.—H. D. Vought, 95 Liberty St., New York, N. Y.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Meeting second Friday of each month, except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio. Business meeting, Hotel Sherman, Chicago, Sept. 6, 1921.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Meeting third Monday of each month, except June, July and August.

PERSONAL MENTION

GENERAL

J. I. Mailer, master mechanic of the Fort Smith & Western, with headquarters at Fort Smith, Ark., has been appointed superintendent of motive power, with the same headquarters. The office of master mechanic has been abolished.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

J. S. Allen has been appointed master mechanic of the Brownville division of the Canadian Pacific, with headquarters at Brownville Junction, Me., succeeding E. Bowie, transferred.

D. D. Briggs has been appointed master mechanic in full charge of the mechanical department of the Alabama, Tennessee & Northern, with headquarters at Mobile, Ala.

J. Kanatser has been appointed road foreman of engines of the Rock Island at Shawnee, Okla.; H. C. McCullough at Pratt, Kan.; B. J. Bonner at Eldon, Mo.; S. F. Hanchett at Des Moines, Iowa; H. T. Demsey at Estherville, Iowa; B. Strauss at Cedar Rapids, Iowa, and J. C. Rhodes at Trenton, Mo.

J. McDonough, master mechanic of the Atchison, Topeka & Santa Fe, with headquarters at Fort Madison, Iowa, has been transferred to the Illinois division, with headquarters at Chicago, succeeding A. L. Beardsley, resigned on account of ill-health.

G. E. Pryor has been appointed master mechanic of the Quanah, Acme & Pacific at Quanah, Tex., succeeding L. E. Wingfield, resigned.

CAR DEPARTMENT

William John Sheppard has been appointed car foreman of the Canadian Pacific at Nelson, B. C. Mr. Sheppard was born at Kemnay, Scotland, September 28, 1882, and entered the service of the Canadian Pacific in September, 1906. From 1906 to 1907 he was a car repairer at Vancouver, B. C.; from 1907 to 1911, a car inspector at Kamloops, B. C., and from 1911 until his recent appointment, car foreman at Revelstoke, B. C.

SHOP AND ENGINEHOUSE

J. W. Finch has been appointed general foreman of the Rock Island shops at El Reno, Okla., succeeding F. D. Buckley, who has been made roundhouse foreman at Eldon, Mo.

J. W. Johnson has been appointed general foreman of the Rock Island shops at Ft. Worth, Tex., succeeding A. F. Davis, resigned.

PURCHASING AND STORES

W. L. Manning has been appointed assistant superintendent of stores of the Chesapeake & Ohio; W. S. McDonald, general storekeeper, Western Division, and R. L. Morris, storekeeper, each with headquarters at Huntington, W. Va.

G. H. Pinion, assistant purchasing agent of the Texas & Pacific, has been appointed general storekeeper, with headquarters at Marshall, Tex., succeeding A. D. Walther, resigned to accept service in another department. The position of assistant purchasing agent has been abolished.

Forty Cents a Plate is the cost of a good noon-day meal at a lunch room which seventeen shop foremen of the New York, New Haven & Hartford have established for themselves at Van Nest, New York City; and at that price they have accumulated in two and a half years a reserve fund of about $500. Van Nest is not well provided with restaurants and so these men got the company to give them an old passenger car and they fixed it up as a dining car (without trucks). The company furnishes hot water and gas. They have a woman cook, and, with a present membership of 40 (foremen and clerks), and an average daily company of eaters of 26, they are maintaining the establishment without difficulty. The woman reporter of the New York Evening Post, who gives these facts, says that this unpretentious "dining car" is beautiful with rosebushes, and that the odor from the kitchen is "savory."

SUPPLY TRADE NOTES

Victor M. Summa has opened an office as general consulting engineer at 415 Merchants-Laclede building, St. Louis, Mo.

The Walworth Manufacturing Company has removed its general offices from its Boston factory, First and O streets, to Pearl and High streets, Boston, Mass.

M. J. O'Connor has been appointed general sales manager of the Gary Industrial Paint Company, with headquarters at 20 East Jackson Boulevard, Chicago.

The Oxweld Acetylene Company, Newark, N. J., has removed the offices of its foreign sales department from Newark, N. J., to 30 East Forty-second street, New York.

Charles Copeland, assistant treasurer of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., has been elected secretary, to succeed Alexis I. du Pont, deceased.

The Webster & Perks Tool Company, Springfield, Ohio, has sold the grinding and polishing stand and accessory department, of its business, to the Hill-Curtis Co., Kalamazoo, Mich.

E. J. Brennan, formerly superintendent of motive power of the Chicago, Milwaukee & St. Paul, Lines East, is now sales manager for The Rogotchoff Company, Baltimore, Md.

The National Machinery Company, Tiffin, Ohio, has opened an eastern sales office in room 637, Knickerbocker building, Broadway and Forty-second street, New York City, in charge of F. J. Mawby.

The Dominion Oxygen Company, Ltd., has begun work on a new oxygen plant at Montreal, Que., to cost $250,000. The building will be 100 ft. by 100 ft., and will be a duplicate of the company's Toronto plant.

The Universal Crane Company, Cleveland, Ohio, has appointed the Allied Machinery Company of America, 51 Chambers street, New York, as its foreign representative, the territory including all countries, except the United States and Canada.

E. E. Hudson, whose election as president of the Waterbury Battery Company, Waterbury, Conn., was announced in the May issue of the *Railway Mechanical Engineer*, died on June 27 at his home in Maplewood, N. J.

Barbour, Love & Woodward, Inc., machine tool dealer, formerly at 149 Broadway, has moved its temporary office and warehouse from 131 Washington street to its new offices and showrooms at 45 West Eighteenth street, New York City.

Goddard & Goddard Company, Inc., Detroit, Mich., has opened an eastern sales office and permanent exhibition of milling cutters in the rooms of the Manufacturers' Exhibit, Inc., 45 West Eighteenth street, New York. James W. Sederquist, eastern sales manager, is in charge of the sales office and exhibit.

De F. Lillis, who has been placed in charge of the recently established office of the Dressel Manufacturing Corporation in the Railway Exchange, Chicago, as noted in the July issue of the *Railway Mechanical Engineer*, was for many years connected with the motive power department of the New York Central.

H. A. Paarman, assistant to secretary of the Burden Iron Company, Railroad & Steamship division, 3711 Grand Central Terminal, New York City, has been appointed secretary, to succeed W. J. Caton, deceased. Mr. Paarman will also continue to serve in the sales department of the Sanitation & Supply Company, New York City.

A. M. Castle & Co., Chicago, has started work on the construction of a new steel warehouse at Blackhawk and North Branch streets, Chicago. The building will be 211 ft. by 232 ft. of fireproof construction. The west end of the building for 75 feet is to be two stories in height and the second floor will provide office space 75 ft. by 211 ft. for the general offices of the company.

The Universal Packing & Service Company, Chicago, in addition to handling spring journal box packing, has enlarged its organization to take care of the railroad field and mid-western commercial field for the development and sale of Rawlplugs, a device which enables an ordinary screw to hold in any material. The Rawlplug Company has its offices at 461-475 Eighth avenue, New York City.

E. W. Crellin, president of the Pittsburgh-Des Moines Steel Company, Pittsburgh, Pa., has retired, and W. H. Jackson, secretary and treasurer, has been elected to succeed him; P. E. Guibert and W. W. Hendrix have been elected vice-presidents, and George A. Smith, secretary and treasurer. A. C. Pearsall has been appointed general manager of the Des Moines, Iowa, branch, succeeding Mr. Smith, who has gone to Pittsburgh, Pa.

Henry S. Manning, who retired in 1905, as senior partner of Manning, Maxwell & Moore, New York, died on July 9, in New York City, at the age of 76. Mr. Manning established the firm of H. S. Manning & Co., New York. In 1880 its name was changed to Manning, Maxwell & Moore, and in 1905 the present corporation was organized. After leaving Manning, Maxwell & Moore, Mr. Manning became interested in the firm of Milliken Brothers, New York. He was a member of the executive committee of the Kansas City, Mexico & Orient Railroad.

The Western Electric Company has opened a new warehouse at 395 Hudson street, New York City. The building occupies the entire square block bounded by Hudson, West Houston, Greenwich and Clarkson streets, an area of 338 ft. by 200 ft., with a total floor space of 706,000 sq. ft. Several departments of the Western Electric Company have already moved into the new quarters, but the New York shops and the supply divisions of the Eastern district territory, which includes New York, New Jersey, Pennsylvania and the New England states, and the International Western Electric Company will not remove to the same building at the present time.

Crerar, Adams & Company, Chicago, Ill., western sales agent for B. M. Jones & Co., Inc., New York, will in future carry a complete stock of Double Mushet high speed steel, also Titanic carbon tool steels, and Taylors' Best Yorkshire Iron, in Chicago. F. W. Clifford, associated for a number of years with Crerar, Adams & Co., as a tool steel expert, will in future specialize on Mushet and Titanic tool steels. The Connelly & Kendal Company, 115 St. Clair avenue, N. W., Cleveland, Ohio, is now managing the Jones company's Cleveland branch, and R. G. White, who was manager of the Cleveland branch, has been appointed special western representative, with headquarters in Chicago.

Will H. Bloss, manager steam railroad sales, of the Ohio Brass Company, Mansfield, Ohio, died suddenly from heart failure at his home in Mansfield on June 22. Mr. Bloss was born on April 4, 1869, and received his engineering training at Indiana University. He started his career in railroad work and subsequently was division engineer on the Santa Fe. He later served as chief engineer of the Indiana Union Traction Company. In 1906 he went to the Ohio Brass Company from the Buda Company of Chicago and was district sales manager in some of the central states until about a year ago. From that time he had devoted his effort to electrification development and other steam railroad problems.

William Aldrich, who has recently been in charge of thermit welding in the southern territory of the Metal & Thermit Corporation, New York, has been transferred to the western territory. William H. Moore, who recently was assigned to the Chicago territory, now has charge of the southern territory. This corporation has constructed and will shortly place in operation in south San Francisco, Cal., a large new plant for the production of detinned billets, in addition to the detinning plants already operated by this company for several years at Chrome, N. J., and east Chicago, Ind. E. Kardos, superintendent, will be in charge of the new plant, which includes a large welding shop. The estimated cost of this plant is $800,000. The San Francisco offices of the corporation have been removed from 329-333 Folsom street, to the new south San Francisco plant.

C. J. Burkholder and Frank H. Cunningham have been appointed special engineers of the Franklin Railway Supply Company, Inc., New York. Mr. Burkholder began railroad work at Tyrone, Pa., and subsequently served first as locomotive fireman and then as locomotive engineman on the Union Pacific. He then went with the Kansas City Southern, as locomotive engineman, later serving consecutively as traveling engineer, trainmaster, general road foreman of engines and division superintendent. He then became mechanical representative of the Economy Devices Corporation, which later merged into the Franklin Railway Supply Company, Inc. In November, 1918, he resigned from the position of western sales manager of the Franklin Railway Supply Company to become master mechanic of the Kansas City Southern, which position he held until his appointment as above noted. Mr. Cunningham was born in Roanoke, Va., on May 23, 1886. After serving an apprenticeship as machinist on the Norfolk & Western, he attended the University of Virginia. Following his graduation with the degree of mechanical engineer, he returned to the Norfolk & Western as machinist, subsequently becoming material inspector, mechanical inspector, assistant engineer of tests and supervisor of locomotive stokers. In 1914 he went with the Standard Stoker Company as fuel engineer, being appointed later to plant manager at Erie, Pa., and assistant general manager, from which position he now resigned to enter the services of the Franklin Railway Supply Company, Inc., as above noted.

F. B. Jewett, chief engineer of the Western Electric Company, has been elected a vice-president and director of the company, continuing his present duties in charge of the technical forces of the company. Dr. Jewett, who was a lieutenant-colonel in the Signal Corps during the war and was decorated with the Distinguished Service Medal, was born at Pasadena, Cal., on September 5, 1879. He was graduated from the electrical engineering course of Throop Polytechnic Institute, of Pasadena, in 1898. From that time until June, 1902, he was a graduate student at the University of Chicago. During the next two years he was instructor in physics and electrical engineering at the Massachusetts Institute of Technology. Dr. Jewett's connection with the commercial telephone business dates from September, 1904, when he became transmission engineer for the American Telephone & Telegraph Company. While acting in this capacity, the loading of eight gage circuits was perfected; phantom tables and phantom loading for open wires and cables were developed; the New York to Denver circuit and line was engineered and also the Boston to Washington underground cable. In April, 1912, Dr. Jewett became assistant chief engineer of the Western Electric Company in charge of all development and research work. He has been chief engineer since 1916. Dr. Jewett was an advisory member of the Special Submarine Board of the Navy and contributed much towards the perfection of devices for detecting hostile submarines. The perfection of wireless telephoning is one of the undertakings which was completed under his direction.

Waterbury Battery Company

The Waterbury Battery Company, Waterbury, Conn., has completed a reorganization of its officers and directors, which has been occasioned by the deaths of Charles B. Schoenmehl and E. E. Hudson. The officers of the company are now Martin L. Martus, of Waterbury, Conn., president; G. A. Nelson, vice-president and general sales manager at New York; Francis T. Reeves, treasurer, and Harold B. Schoenmehl, secretary, both at Waterbury. The directors are: Francis T. Reeves, Martin L. Martus and Darragh De Lancey.

Martin L. Martus, who has been elected president, has been associated with the company since April, 1911; for the past nine years as secretary and factory manager. He was born in New Haven, Conn., and became associated with the Scovill Manufacturing Company in 1901. In 1906 he was chief engineer for one of the subsidiary plants of the American Brass Company, and in 1911 became associated with the Waterbury Battery Company as factory manager, which position he has held until the present time.

Judge Francis T. Reeves, treasurer, was born in Thomaston, Conn., and has been a director of the Waterbury Battery Company since October, 1916, and its general counsel since 1914. He is director and trust officer of the Manufacturers National Bank, of Waterbury, Conn., and is a practising attorney in Waterbury.

Harold B. Schoenmehl, the newly elected secretary, is the eldest son of the late Charles B. Schoenmehl. He has been associated with the Waterbury Battery Company for the last six years, engaged in laboratorial and experimental work.

Darragh De Lancey, the newly elected director, was formerly president of the Waterbury Chamber of Commerce and during the war served with the War Department and the United States Shipping Board.

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CONTENTS

EDITORIAL:
High Production Machinery.... 535
Needs of Smaller Locomotive Terminals.... 535
Location and Grouping of Machine Tools.... 536
New Lease of Life for Weak Cars.... 536
Is Piece Work the Issue?.... 536
Main Rod Repairs.... 537
Material-Handling Devices and Shop Layout.... 537
Stop Waste of Fuel at the Source.... 537

COMMUNICATIONS:
Rusting of Steel Containing Copper.... 538
New Books.... 538

GENERAL:
The Comparison of Dimensions and Productions of British Locomotives.... 539
Physical Properties of Oils for Lubricating Air Compressors.... 542
Speeding Up Locomotive Main Rod Repairs.... 543
Insulation of Passenger and Refrigerator Cars.... 547
A Welded Locomotive Tender Tank.... 550
Cost of Operating Obsolete Machine Tools.... 551
The "DeWitt Clinton" Moves Under Its Own Power.... 553
Jig for Machining Reversing Valve Bushing Seats.... 553
Modern Equipment Facilitates Flue Shop Work.... 554
Steam Hammer Repair.... 558
Labor Board Settles Overtime Controversy.... 559
Fuel Conditions on the French Railways.... 562
Mix Thermit Thoroughly Before Using.... 564
No Meeting of Mechanical Division This Year.... 565
Joint Committee on Joint Inspection of Standard Materials.... 569
Report of Arbitration Committee.... 569
Prices for Labor and Material.... 572
Report of Car Construction Committee.... 572
Report of Committee on Loading Rules.... 576
Brake Shoe and Brake Beam Equipment.... 579
Report of Committee on Tank Cars.... 586
Report on Train Brake and Signal Equipment.... 588
The Use of Powdered Fuel Under Steam Boilers.... 589
Step Ladder for Car Shops.... 590
Boiler Ruptures with Man in Firebox.... 590

NEW DEVICES:
Adaptable 90-In. Journal Turning Lathe.... 591
Easily Detachable Hand Rail Column.... 592
Device for Cutting Gear Pattern Tooth.... 593
Divided Machine Vises Adjustable in Height.... 593
Power Sheet Metal Squaring Shear.... 594
Eliminating Blow Holes in Thermit Welds.... 594
Cold Junction Compensated Pyrometer.... 595
Gantry Drill for Tank Car Work.... 596
A Dynamometer for Milling Machines.... 596
Belt Sanding and Polishing Machine.... 597
Short-Turn Overhead Trolley System.... 597
Special Hydraulic Driving Wheel Press.... 598

GENERAL NEWS:
Notes.... 599
Meetings and Conventions.... 602
Personal Mention.... 602
Supply Trade Notes.... 603
Trade Publications.... 604

High Production Machinery

In view of the results accomplished with specialized, high-production machinery in some of the more modern equipped railroad shops no one can doubt the advisability of more generally installing these machines as fast as circumstances and the financial condition of the railroads permit. It is a mistake, however, to recommend the installation of any machine simply because it is modern, powerful and designed for high production. These machines are of necessity more or less expensive and unless there is work enough available to keep them in operation a large proportion of the time, interest and depreciation charges on the investment will more than equal what has been saved by increased production while the machine was in operation. It has always been the policy of the *Railway Mechanical Engineer* to advocate installing labor saving machinery and equipment in railroad shops but only after a detailed study of the situation and careful balancing of cost against possible savings. In the words of a prominent mechanical department officer "modern high-power shop machinery should be selected with extreme care. A time-study should be made of machine operations, and machine tools that cannot produce to the capacity of modern tools, should be abolished or used only in cases of emergency. The higher capacity tools should be operated on two shifts in order to secure a greater production."

No industrial manufacturer would think of ordering new machinery until a careful study had been made of the situation, finding out the exact machinery which will best serve his purpose and determining as accurately as possible what saving may be effected. The time is coming, and in fact is now here, when railroad shops must be managed with the same degree of care and business judgment as is found in any successful business venture. Railroad mechanical officers should study their machine tool requirements as carefully as an industrial manufacturer who must meet competitor's prices. Careful statements can then be prepared, taking into account all contributory factors, balancing costs against possible savings, and showing at a glance whether or not it will pay to install the high production machines in question.

Needs of Smaller Locomotive Terminals

The smaller locomotive terminal and its needs have too often been forgotten or passed by with the thought that the men can continue to worry along somehow at such points with what they have. It is fully as important as at the larger terminals that the arrangement of tracks and the facilities for coaling, taking water and cleaning fires be such that the locomotive can be gotten into the house as promptly as possible if repairs have to be made. Even though repairs may be made out-of-doors, such work is done under difficulties in bad weather and is practically impossible in the winter time in the north. It is too much to expect that good men will continue to work under uncomfortable conditions. In addition, men working by themselves out-of-doors cannot be adequately supervised and it also necessitates expensive movements of men and material. The minor terminal is necessarily at a disadvantage in the equipment of machine tools as compared with the larger points. There is frequently a possibility of improving conditions in this respect by transferring tools that are not sufficiently modern to meet the requirements of the main shops and replacing them by improved modern tools.

Another point of weakness in the minor terminal and one that can be corrected at a small expense is the inadequate equipment of hand tools and in the lack of suitable small tools for the few machine tools which are provided. To obtain the greatest benefit for such tools they should be taken care of properly and where tool dressing facilities are lacking, as is frequently the case, they should be returned systematically to the main shop for redressing or replacement, as required. A good mechanic who has some ingenuity can do wonders with a hammer, a cold chisel and a file, but it is always done at a far greater expense than if he had been provided with a few conveniences so taken care of that needless time was not wasted in hunting up something to do the job with.

Location and Grouping of Machine Tools

In the consideration of plans for increased production and reductions in the cost of performing work the advantages to be derived from new and improved machine tools is usually given first consideration. While there is undoubtedly a pressing need for new equipment in most railroad shops, the economies that can be obtained by care in the location and grouping of machine tools is a matter that is far too often overlooked. The importance of a consideration of this feature applies not only to the placement of new machines; marked economies in operation and an increase in shop production can frequently be obtained by regrouping existing equipment. In successful manufacturing plants the arrangement of buildings and the layout of machines is made a subject of careful study in order that material from the time it is received at one end of the plant in the form of castings, forgings, sheets, etc., shall move in as direct a route as possible from one operation to the next until it is finally inspected and delivered to the storeroom or shipping department at the other end of the plant.

While few railroad shops are used primarily for manufacturing operations the underlying principles are equally applicable in shops designed and operated for the repair and maintenance of locomotives and cars. In too many shops large and important jobs cannot be performed without moving the work from one point to another and back again before it is finished. Unnecessary movements or movements of unnecessary length are costly, even if suitable cranes and material-handling equipment are available, and they always mean delays. In studying the question of machine location the preparation of routing diagrams for the movements of the more important or more frequently performed operations will often show distinctly the existence of conditions that have been overlooked and will be of the greatest aid in correcting the situation.

New Lease of Life for Weak Cars

Wooden cars with weak draft sills have been a seriously disturbing factor in railroad operation for many years. They are the cause of numerous wrecks and accidents, they require excessive maintenance expenditures and frequent transfers of lading and they are a fruitful source of claims for loss and damage to freight. For seven years the desirability of keeping them out of interchange has been discussed before the Master Car Builders' Association and its successor, the Mechanical Division of the American Railway Association. The adoption by letter ballot in 1914 of a provision in Rule 3 of the Interchange Rules to the effect that cars of less than 60,000 lb. capacity be not accepted in interchange after October 1, 1916, is ample proof that the desirability of eliminating these cars was widely recognized. And yet the effective date of this provision has been advanced from year to year and these cars are still running in interchange. As the rule now stands the time limit is October 1, 1922, but in this year's report the Arbitration Committee recommends a further extension to October 1, 1923. There is no lack of appreciation of the common interest of the railroads to improve equipment conditions, but the record suggests that no concerted action toward that end can be accomplished so long as this common interest does not appear to be entirely in harmony with the immediate interests of the individual roads. So long as the railroads are privately owned and operated this condition will continue.

This situation suggests that the incentive of individual interest be recognized and that advantage of it be taken in the Interchange Rules to bring about improvements in equipment conditions which direct appeals to the common interest have failed, and will continue to fail, to effect. The present prices for labor and materials fixed by the Interchange Rules on a bare cost basis offer little inducement for the proper maintenance of foreign cars and are demoralizing in their effects upon car owners as well. Certainly, a code of prices which compels the handling line to make repairs at cost is not likely to foster the keenest sense of responsibility for the care of its own equipment on the part of the owner. Neither is the handling line likely to keep foreign cars out of service for more than the minimum of repairs required for actual movement, while in the meantime it must donate to the owner the use of the car at the rate of a dollar a day. A scale of prices for labor and material properly adjusted to include an average profit of not less than 10 per cent not only would stimulate the interest of the handling line in foreign equipment but would bring directly home to the owning line its responsibility to keep its equipment in condition to meet the requirements of modern railroading. The final disappearance of the weak equipment which has so long been a troublesome factor in the problem of efficient operation would be hastened and the general standards of construction and maintenance would be elevated.

Is Piece Work the Issue?

Statements presented by the railroads before the Labor Board early in the year showed decreases in productive efficiency of railway shop employees ranging from 10 per cent to 50 per cent following the abolition of piece work by the Railroad Administration in 1918. The railroads maintain that these reductions were the direct result of the distortion of the guaranteed minimum hourly rate in relation to the piece work rate, finally followed by the complete abolition of piece work. Accepting as facts the reductions in output as measured by the average hourly earnings at piece work rates, the Railway Employees' Department of the American Federation of Labor in its exhibit recently presented, contended in rebuttal that these decreases are merely reflections of increases in the number of men employed, attributable in part to the increasing difficulty of promptly supplying needed tools and materials as the number of men employed increases, thus creating a handicap on output which is reflected in decreased average hourly piece work earnings.

In its direct attacks on the piece work system, the Railway Employees' Department maintains, first, that the varying amounts of skill and effort required in repeated performances of the same operation or combination of operations in a repair shop is so great that piece work rates cannot be established with accuracy or strictly adhered to in practice, and second, that the unit costs of locomotive maintenance of a group of roads in the Alleghany region working under piece work schedules are consistently greater than the unit cost of a group of railroads in the Northwestern region working on a time work basis. Little weight need be given to the latter contention since it is obviously impossible to make accurate comparisons between individual railroads or groups of railroads, because the results will be affected by differences in the type of power, in climatic conditions, in the quality and quantity of repair shop facilities, and in the character of the feed water supply as well as differences in the topography of the lines.

There are undoubtedly many operations in a repair shop for which satisfactory piece work rates cannot be established;

on the other hand there are operations the performance of which is well adapted to payment on a piece work basis. Some piece work schedules may contain numerous inconsistencies, owing to an effort to establish prices on operations the performance of which cannot be standardized. Other more limited schedules may be developed which are not open to this objection. Can a principle, the fundamental correctness of which has not been attacked even by the Railway Employees' Department, be condemned because its application and administration has not been perfect? Is not the adoption or rejection of piece work a matter which may properly be left for settlement by negotiations between local representatives of the employees and the managements? It is extremely doubtful if its adoption can be prevented in any shop where it proves to be mutually agreeable to the management and the men.

The real issue is not piece work; it is this: Are we to have nationalized management of the railroad shops by the American Federation of Labor through the instrumentality of the United States Railway Labor Board, or are we to have private management of railroad shops, along with the rest of the railroads, in accordance with the Transportation Act, with the Labor Board serving as a tribunal of justice to facilitate and not to hamper the efficient operation of the properties? Until that question has been settled the piece work controversy is not of first importance.

Main Rod Repairs

While the rod department occupies a relatively small proportion of the total floor space in a railroad shop and employs comparatively few men, it is an important department and in many cases under present conditions limits the output of the shop. No railroad repair shop can handle locomotives faster than it can repair the rods needed for those locomotives. In addition to caring for engines undergoing general repairs, the rod department is often expected to provide rods for locomotives needing light repairs and others held out of service at roundhouses for rod work. This outside work is a most disturbing feature as it entirely upsets the shop schedule to have a set of rods come in requiring practically general repairs that must be completed ahead of rods needed for outgoing locomotives. The fact remains, however, that this condition does exist and the rod department must have sufficient reserve capacity to make all repairs promptly.

Perhaps one of the best ways to increase the capacity of the rod department is by eliminating as far as possible hand filing and fitting of main rod front and back end brasses. A timely article on this subject, showing the machinery and methods needed for the work, is published elsewhere in this issue under the title of "Speeding Up Locomotive Main Rod Repairs." The author has gone into the subject in considerable detail and without anticipating too many of his conclusions it may not be amiss to say that the use of a rugged surface grinder for truing the sides of the rods and a high-power milling machine for truing and squaring the rod jaws will do much to increase the accuracy of main rod repairs and assist materially in reducing hand work.

In machining back end brasses the use of an indexing fixture to machine one pair of brasses at a time is recommended. This work is usually done on a milling machine, crank planer or shaper. "With a well-made indexing fixture," says the author, "brasses are machined in some shops so accurately that they are a satisfactory fit in the rod, and no filing is necessary except to remove burrs." The use of micrometer calipers is essential and increases the accuracy of the work, being a great improvement over fit-and-try methods.

Attention is directed to the fact that the question of milling versus shaping brasses from the rough castings will be dependent largely upon the quality of brass or bronze used. In some cases there is no doubt that the difficulty and cost of keeping milling cutters sharp when machining brass castings with hard outside scale has far more than offset any saving due to the substitution of milling for shaping operations. Special fixtures for holding front end main rod brasses while being machined are illustrated and described in the article which advocates the use of milling machines wherever the quality of the brass or bronze warrants. The closing paragraph of the article is an able summary of arguments for and against machine fitting of main rod brasses, the conclusion being strongly in favor of machine fitting because of greater accuracy in the work and reduced labor cost.

Material-Handling Devices and Shop Layout

The function and importance of material-handling equipment in connecting one machine with another should always be kept in mind. From the time work is started until it is finished and delivered to the erecting shop or roundhouse it must be moved from one machine or point to another as conditions require. While much can and should be done to reduce such movements to a minimum, consideration should be given to the means by which necessary movements of material are performed. Where more than one method is available, a proper selection may expedite the movement and reduce its cost, for every movement means an added cost. Even where crane service has been provided for, delays in waiting for a crane and the high cost of crane operation may render an overhead track system equipped with suitable electric or pneumatic hoists an economical addition. Aisles should be suitably arranged and kept free from obstruction so that they can be used for the rapid movement of materials by industrial cars or by industrial trucks which are the most economical equipment for moving materials a considerable distance. For the loading and unloading of such trucks and cars and for moving material to and onto the larger machines an overhead track and hoist can frequently be used as a substitute for or supplementary to a crane. Another simple device which is being increasingly used in manufacturing shops and which might sometimes be used to advantage in railroad shops for transferring work from one machine to another nearby machine is a section of gravity roller conveyor. In plans for the layout of tools in a shop, both the movement of material and the means to be used should thus be given consideration. The field in which the largest benefits can be realized on most roads is in the older and smaller shops which have not hitherto been provided with the material-handling devices which are commonly found in the larger modern shops.

Stop Waste of Fuel at the Source

On the majority of roads the mechanical department is held responsible for fuel economy, principally because the condition of locomotives and the manner of handling them is the biggest single factor in the economical or wasteful use of the fuel. It follows that everyone having to do with the maintenance or operation of the power has a direct responsibility for fuel economy. In practice, however, the road foremen of engines are usually held chiefly responsible for the fuel performance. Shops and roundhouses are likely to consider it a secondary matter except when a special drive for fuel economy is being made by the road. The supervision exercised by the traveling engineer is not sufficient to locate even the important defects that waste fuel, because most roads employ only one traveling engineer for each fifty to eighty locomotives and fuel supervision is only one of his duties.

To insure the best results the roundhouse forces must be organized to stop the waste of fuel at the source by correcting conditions that make locomotives uneconomical. It should not be necessary to wait until the locomotive uses such an excessive amount of coal that it becomes noticeable to the crew before mechanical defects are corrected. A thorough periodical inspection will disclose the defects and by making repairs promptly a great deal of waste will be avoided. It should be said in justice to roundhouse men that the majority of them do not need much instruction in keeping locomotives in economical operating condition but they do need supervision to see that other duties do not cause them to overlook some of the simple things that are the very essentials of fuel economy. The engine inspectors can be depended upon to notice a loose bolt or a tire flange that is cutting, but leaky steam pipes, cylinders and valve packing or valves incorrectly set are not so easily found and unless special care is taken they are likely to be passed by. Too often the important matter of keeping sufficient air openings in grates and cleaning tubes and flues is considered as just a dirty job to be finished as quickly as possible, and the lack of attention results in loss of heating service and low superheat with a corresponding increase of fuel consumption. Such examples could be multiplied, for, as stated before, fuel economy is a matter that concerns every employee. When the shops and roundhouses are organized to insure that these matters receive such persistent attention that the proper practice becomes a habit, a big step will have been taken in securing economy in the use of fuel.

COMMUNICATIONS

Rusting of Steel Containing Copper

Pittsburgh, Pa.

To the Editor:

In the May, 1921, issue of the *Railway Mechanical Engineer,* page 291, there appeared an article entitled "The Rusting of Steel Containing Copper," which was a brief abstract of an article by Professor O. Bauer of Berlin which appeared in Stahl und Eisen of January 13 and 20, 1921.

It is unfortunate that the abstractor in quoting the chemical analyses of the sheets used by Professor Bauer did not mention the copper content as given in Tables 2 and 5 in the original article. By referring to the above mentioned tables, it will be found that the steel to which Professor Bauer added amounts of copper up to 0.35 per cent already contained approximately 0.10 per cent copper. He was, therefore, adding copper to a steel already containing nearly, if not quite sufficient copper, to give the maximum corrosion resistance. Numerous corrosion tests made by the writer and others have shown little difference between steels containing 0.10 per cent and 0.25 per cent copper, whereas comparing steels with only a slight trace of copper with steel containing 0.25 per cent of this element, a very marked superiority is found for the latter under all conditions of atmospheric corrosion.

Failures of Copper-Bearing and Non-Copper-Bearing Sheets, A. S. T. M. Corrosion Tests

Type Designation	Gage	Number of groups	Total number of sheets	Number failed	Total failures at each inspection, expressed as percentages of total sheets of each type exposed							
					10 Mo.	16 Mo.	22 Mo.	28 Mo.	35 Mo.	41 Mo.	46 Mo.	52 Mo.
Copper-Bearing.....	16	14	132	None	.....	.....	.....	.....	.....	.....	.....	.....
Non-Copper-Bearing.	16	11	126	54	None	None	None	10.3	15.9	26.2	32.6	42.9
Copper-Bearing.....	22	15	146	93	None	None	1.4	4.1	13.7	27.4	44.5	63.7
Non-Copper-Bearing.	22	11	84	82	None	35.7	79.7	91.6	94.0	96.4	96.4	97.6

The American Society for Testing Materials, through their Committee A-5 on Corrosion, started a series of tests in 1916 in three different characters of atmosphere, namely, in the industrial air of Pittsburgh, Pa., the pure air of an inland district at Fort Sheridan, Ill., and salt air, such as occurs at Annapolis, Md. The results of this test have been given in the annual reports of the society, beginning with 1918, and I quote from the 1921 report:

> "The results of the observations at the Pittsburgh tests have now reached a point where we may definitely conclude that copper-bearing metal shows marked superiority in rust resisting properties as compared to non-copper-bearing metal of substantially the same general composition, from which superiority we may truly anticipate a marked increase in the service life for copper-bearing metals under atmospheric exposure of uncoated sheets.
>
> "It is interesting to note in this connection that the lighter gage non-copper-bearing Bessemer and open hearth metals, which failed first at Pittsburgh, have also failed first at Fort Sheridan, which would indicate that the two different atmospheric conditions have shown substantially the same general tendencies, only with varying rates of corrosion."

The accompanying table, which is also copied from the official report of Committee A-5, indicates the comparative life of copper-bearing and non-copper-bearing sheets.

That a copper content of 0.10 per cent has material influence on the corrosion rate, in fact that that amount is nearly as good as 0.25 per cent, is shown in a paper presented by the writer at the 1919 meeting of the American Society for Testing Materials, entitled "The Influence of Very Low Percentages of Copper in Retarding the Corrosion of Steel." In this article it is shown from exhaustive tests, under atmospheric conditions, that in a low sulphur heat (0.031 per cent sulphur), 0.08 per cent copper is sufficient to give the maximum corrosion resistance, and in the higher sulphur heat (0.055 per cent sulphur), 0.10 per cent copper gives very nearly the maximum benefit.

From the tests above mentioned, it is not unreasonable to conclude that had Professor Bauer started with a steel containing none or only the usual slight trace of copper, his results and conclusions would have been entirely different, and would have confirmed the test made by the American Society for Testing Materials.

D. M. Buck,
Metallurgical Engineer, American Sheet & Tin Plate Co.

NEW BOOKS

Saward's Annual Statistical Review of the Coal Trade. 254 *pages, including advertising,* 6 *in. by* 8 *in. Published by Frederick W. Saward,* 15 *Park Row, New York.*

To men who are connected with the purchase or use of coal, a compilation of data regarding the operation of previous years is of value. This book provides information not otherwise readily available, giving in very complete form statistics of production and shipment with considerable information pertaining to the consumption of fuel. Sufficient comment on conditions in the industry are given to aid in interpreting the figures presented. The situation existing in 1920 is reviewed for the country as a whole and also for the principal producing districts and market centers. Production of both anthracite and bituminous is given for many of the principal companies, as well as for the various fields and for all the states. A large amount of data regarding prices is given, including quotations as early as 1834. The wage rates and the texts of the wage awards for both bituminous and anthracite are quoted. The tonnage shipped over various railroads is given, as well as the amount carried by water, the receipt at the lakes and the amount exported. In addition to the data regarding coal, figures are given for the production and consumption of petroleum.

Great Northern Railway Three-Cylinder Type Locomotive for Fast Freight Service, Designed by H. N. Gresley, Locomotive Engineer, Built 1920, Doncaster Shops

The Comparison of Dimensions and Proportions of British Locomotives

BY E. C. POULTNEY

THE writer has dealt previously with British locomotive practice in the columns of the *Railway Mechanical Engineer,* and the present article supplements the information already given, and at the same time offers a few notes on the general subject of the comparison of locomotive dimensions. The latter part of the subject will be taken first, and in conclusion some brief reference will be made to British practice as exemplified by the various designs embodied in the tables of dimensions which accompany this essay.

Discussing in the first place the various factors which are required in order that one locomotive may be compared with another, it is suggested that the following may be satisfactory, each being designated by the symbol used.

Factors

Factor of Adhesion, A

$$A = \frac{\text{Adhesive Weight}}{\text{Rated Tractive Effort}}$$

This is of course simply the ratio of proportion between the average force tending to rotate the driving wheels and the weight or force by which the driving wheels are pressed on to the rails.

Generally it is considered that the rated tractive effort at the rim of the drivers should be not greater than one-fourth of the weight tending to press the wheels on the rail; or, in other words, the factor of adhesion should be 4. The above holds good when the rails are clean and dry, and under reverse conditions considerably more weight is necessary to prevent slipping, hence a factor of 4 should be taken as a minimum figure in order that the locomotive should not, under average weather conditions, be excessively "slippery" at starting. For locomotives employed in working local passenger trains making frequent stops and which have to get into speed quickly after starting, it is undoubtedly advantageous to increase the weight available for adhesion relatively to the maximum average tractive effort so as to minimize the chances of slipping, and the same applies to engines to be used for shunting or switching operations. For locomotives used generally in "through" services, that is making fairly long runs without stops where rapid acceleration has not the same need for consideration, a factor of 4 will usually be sufficient, because the natural reduction in tractive force as the speed increases will counteract any tendency to slip. Table I which gives particulars of the adhesive factor of modern superheated locomotives brings the characteristics of the different types into prominence.

It will be noted that all but one of the 14 types of engines mentioned have a ratio of over 4 as the average value for the factor A. The 4-4-0 type engines have a factor of 4.25 while with the 4-4-2 engines there is a tendency to use a factor of lower value due to their larger boilers making the use of greater cylinder capacity possible.

TABLE I

VALUES OF THE ADHESIVE FACTOR, A; MODERN SUPERHEATED LOCOMOTIVES

Engine type		Maximum	Minimum	Average	Reference
4-4-0	Tender engines..........	5.86	4.02	4.25	Table 1
4-4-2	Tender engines..........	4.6	3.8	4.2	" 2
4-4-2	Tank engines............	4.3	4.1	4.2	" 2
4-4-4	Tank engines............	4.7	4.3	4.5	" 2A
4-6-0	Tender engines..........	6.2	4.3	5.3	" 3
2-6-0	Tender engines..........	5.3	4.3	4.2	" 6
0-6-0	Tender engines..........	5.2	3.7	4.5	" 7
4-6-2	Tender engines..........	...	...	4.8	" 8
4-6-2	Tank engines............	6.2	4.3	5.4	" 8
4-6-4	Tank engines............	...	...	5.2	" 10
2-6-4	Tank engines............	7.3	4.9	6.1	" 9
2-8-0	Tender engines..........	5.1	3.3	4.4	" 4
0-8-0	Tender engines..........	5.2	4.3	4.7	" 5
0-10-0	Tender engines..........	...	...	3.8	" 4A

The six coupled locomotives of the 4-6-0 type have boilers of about the same size as those of the Atlantics, but can have 50 per cent more adhesive weight, and the value of A is therefore greater. If the cylinders were larger so as to absorb a greater percentage of the weight available for adhesion, then they would be too large in proportion to the heating surfaces for express services. This will be appreciated on comparing the Boiler Factors of the 4-4-2 and 4-6-0 engines.

Tank engines of the six coupled type and the 0-8-0 tender engines are both well provided with adhesive weight which is more readily obtainable than heating surface, especially in the tank locomotives.

Rated Tractive Effort, R T E

$$\text{R. T. E} = \frac{d^2 \times s \times P \times 0.85}{D}$$

The usual formula for calculating the Rated Tractive Effort is used as above, the symbols employed have values corresponding with those in the columns of the tables of dimensions. Thus *d* and *s* indicate the diameter and stroke of the pistons, and *D* the diameter of the driving wheels, and *P* the boiler pressure. The mean effective pressure is assumed to be equal to 85 per cent of the boiler working pressure *P*. In his excellent report on express locomotives read before the International Railway Congress in London in 1895. J. A. F. Aspinall used 70 per cent (P × 0.7) for the average pressure, and the late S. W. Johnson in his presidential address to the Institution of Mechanical Engineers in 1898 used a mean effective pressure equal to 75 per cent in calculating the maximum tractive effort. However, while there appears no strict uniformity it now seems that 85 per cent is a figure quite generally adopted, and as the writer has always used this value it is for these reasons adopted for the purpose of the present article.

TABLE II

AVERAGE VALUES OF BOILER FACTORS *B* AND *BD* AND COMBUSTION FACTOR *C* AND DRIVING WHEEL DIAMETER *D* FOR MAIN LINE TENDER ENGINES FROM TABLE III

Engine type	B	BD	C	D
4-4-0	14.2	1216	72.1	81
4-4-2	11.1	904	78.7	80
4-6-0	13.6	1047	78.6	77
2-6-0	17.0	1099	72.4	66
2-8-0	19.1	1004	80.0	60
0-8-0	19.7	1090	81.1	53
0-6-0	20.9	1001	71.0	60

Boiler Factor, B

$$B = \frac{\text{Rated Tractive Effort}}{\text{Total Heating Surface (evaporative)}}$$

This factor indicates the amount in pounds of tractive effort to be supplied by each square foot of heating surface when the engine is running in full gear. In comparing two locomotives having different boiler factors and running at the same speed in miles per hour, the horse power to be furnished per square foot of evaporative heating surface will be measured by the respective values of B calculated as above.

Boiler Demand Factor, B D

$$\text{B.D.} = \frac{\text{Rated Tractive Effort} \times \text{Driving Wheel Diameter}}{\text{Total Heating Surface (evaporative)}}$$

The boiler demand factor as above expresses the horsepower to be developed per square foot of heating surface when the speeds in revolutions per minute are the same, it being assumed that the diameter of the driving wheels is proportional to the speeds in miles per hour at which the locomotives are intended to most usually operate. The general idea underlying the choice of both the factors *B* and *BD* was delineated by Lawford H. Fry writing in "The Engineer" of Oct. 13, 1911, and again in the *Railway Mechanical Engineer* of April, 1921, and therefore need not be repeated

If two locomotives are both developing the same percentage of their rated tractive effort, and both traveling at the same speed in miles per hour, then the power required per square foot of heating surface is measured by the respective values of *B*; and again, if the speeds in revolutions per minute be the same, then the power to be developed by each square foot

TABLE III

BOILER AND COMBUSTION FACTORS OF SELECTED EXAMPLES FROM TABLES 1 TO 7, INCLUSIVE; SUPERHEATED LOCOMOTIVES FOR MAIN LINE SERVICE

Railway	R.T.E.	D	B	BD	C
		4-4-0 *Type*			
L. N. W........	20,000	81	12.9	1,045	82.6
G. C. R.........	19,800	81	11.9	980	72.0
N. E. R.........	15,600	82	14.7	1,210	53.7
L. C. D. S. E....	19,100	80	13.5	1,080	76.5
C. R.	21,432	78	16.2	1,260	74.0
N. B.	20,400	78	15.9	1,239	75.0
G. W. R.........	20,600	80½	13.9	1,112	82.4
L. & Y..........	18,300	87	20.6	1,795	58.4
M. R............	17,200	84½	14.7	1,240	70.3
	......	81	14.2	1,216	72.1
		4-4-2 *Type*			
N. E. R.........	19,161	82	13.0	1,063	74.0
G. N. R.........	17,300	80	8.5	690	83.6
L. B. S. C.......	20,800	79½	10.2	815	80.5
N. B............	23,400	81	12.8	1,051	76.7
	......	80	11.1	904	78.7
		4-6-0 *Type*			
L. N. W. R......	23.800	81	13.6	1,093	69.8
G. C. R.........	24,772	81	12.1	980	92.0
G. W. R.........	25,100	80½	13.6	1,095	78.7
G. S. W. R. I....	18,900	79	10.6	845	78.0
L. S. W. R......	25,200	79	13.4	1,060	73.0
G. E. R.........	22,000	78	13.5	1,057	73.8
L. N. W. R......	21,000	75	13.3	1,000	73.5
L. & Y..........	29,000	75	14.5	1,120	94.5
N. E. R.........	30,032	68	19.1	1,300	77.5
C. R............	21,155	73	12.6	922	75.7
	......	78	13.6	1,047	78.6
		2-6-0 *Type*			
G. N. R.........	30,000	68	15.7	1,055	82.3
L. B. S. C.......	25,800	66	19.9	1,315	63.5
G. S. W. R......	23,700	60	15.9	953	65.0
G. W. R.........	25,700	68	17.4	1,183	82.5
S. E. C. D. R....	25,700	66	16.8	1,112	69.3
C. R............	19,424	60	16.3	981	72.0
	......	66	17.0	1,099	72.4
		2-8-0 *Type*			
G. N. R.........	32,600	56	15.6	880	91.6
G. C. R.........	31,324	56	17.2	827	81.7
G. W. R.........	35,200	55½	19.1	1,060	79.0
S. D. J. R.......	36,360	55½	27.4	1,525	59.0
G. W. R.........	30,600	68	16.6	1,129	80.0
	..... .	58	19.1	1,004	80.2
		0-8-0 *Type*			
N. E. R.........	39,960	55¼	23.4	1,295	77.5
L. N. W. R......	27,800	53½	15.6	840	91.0
L. & Y..........	34,000	54	16.4	890	96.0
G. N. R.........	27,700	56	23.8	1,335	60.0
	......	54	19.7	1,090	81.1
		0-6-0 *Type*			
G. E. R.........	29,044	59	17.8	1,048	69.2
M. R.	22,490	63	19.2	1,210	70.7
H. & B..........	22,600	60	20.5	1,232	72.6
L. & Y..........	26,500	61	30.4	1,860	57.6
N. B.	23,300	60	16.6	995	87.5
N. E. R.........	21,412	55¼	24.9	1,377	66.3
G. C. R.........	21,620	62	17.2	990	73.2
	......	60	20.9	1,001	71.0

NOTE.—The following are the complete names of the railways indicated by abbreviations in the tables:

C. R..............	Caledonian.
F. R..............	Furness.
G. C. R...........	Great Central.
G. E. R...........	Great Eastern.
G. N. R...........	Great Northern.
G. S. W. R........	Glasgow & South Western.
G. S. W. R. I.....	Great Southern & Western (Ireland).
G. W. R...........	Great Western.
H. & B............	Hull & Barnsley.
L. B. S. C........	London Brighton & South Coast.
L. C. D. S. E.....	South Eastern & Chatham.
L. & N. W. R.....	London & North Western.
L. S. W. R........	London & South Western.
L. & Y............	Lancashire & Yorkshire.
M. R..............	Midland.
Met. R............	Metropolitan.
N. B. R...........	North British.
N. E. R...........	North Eastern.
N. S. R...........	North Staffordshire.
S. D. J. R........	Somerset & Dorset Joint.
S. E. C.-D. R......	South Eastern & Chatham.
S. E. C. R........	South Eastern & Chatham.

of heating surface will be measured by the respective values of BD. If two engines have driving wheels of equal diameters then at the same speed in miles per hour the revolutions per minute will be equal, and it is evident that they will show the same relationship whether compared by the factor B or BD. When, however, it is desired to compare locomotives of the same type but having driving wheels of different diameters and intended to work at different speeds in miles per hour, but making an equal number of revolutions per minute, then the factor BD expresses the relation between the respective power demands made per square foot of heating surface. The percentage of the maximum tractive effort engines can exert will depend more directly on the revolutions made per minute than on the speed in miles per hour, for this reason the factor BD is usually the better value for comparative purposes, and has therefore been chosen for inclusion in the tables of proportions.

The supplementary Table II has, however, been prepared which presents a comparison of the factors B, BD and C for selected examples of superheated main line tender engines for both passenger and freight service.

TABLE IV

Proportions of Typical Locomotives, Using Saturated Steam, for Express Passenger and Freight Traffic

4-4-0 *Type*

					FBS			
Railway	R. T. E.	D	B	BD	St.	C	A	E
L. & Y.	14,800	87	12.2	1,061	8.9	64.8	4.6	82.6
M. R.	17,200	84	12.1	1,020	8.9	66.9	4.4	79.7
M. R.	19,200	81	12.6	1,020	9.5	61.0	4.1	77.0
L. N. W.	17,200	81	8.7	708	8.2	87.5	4.9	67.5
N. E. R.	22,000	82	12.7	1,039	9.0	64.3	4.2	74.3
G. W. R.	17,800	80½	9.8	778	6.8	88.5	4.3	66.4
C. R.	18,430	78	11.4	890	9.0	76.8	4.3	76.9
S. E. C. D. R.	18,900	78	12.3	962	8.9	72.1	4.0	76.6
F. R.	14,700	78	11.5	786	6.3	70.5	...	76.6
	......	..	11.4	918	8.5	72.5	4.3	75.3
4-4-2 *Type*								
G. N. R.	15,800	79½	10.9	870	...	55.5	4.4	90.0
L. B. S. C.	19,000	79½	7.6	618	*5.5	79.4	4.4	61.2
G. N. R.	15,800	79½	6.3	503	*5.6	81.0	5.1	58.7
N. E. R.	23,200	82	9.4	775	7.3	90.8	3.7	65.8
G. C. R.	18,680	81	9.7	693	6.9	73.5	4.4	80.0
L. & Y.	16,030	87	8.3	720	8.3	84.2	4 8	64.3
N. B. R.	23,400	81	10.4	840	8.2	79.2	3.8	73.5
	......	..	8.6	717	6.9	77.7	4.3	67.2

*Wide fire-box. †Four cylinders 14¼ in. by 26 in. simple expansion.

0-6-0 *Type*

					FBS			
Railway	R. T. E.	D	B	BD	St.	C	A	E
C. R.	21,430	60	14.8	887	8.1	72.5	5.1	76.0
C. R.	20,200	60	14.5	870	8.4	67.9	4.7	71.4
M. R.	20,930	63	14.6	925	...	67.0	5.1	68.4
L. & Y.	21,200	61	17.5	1,070	8.9	64.4	4.3	77.9
S. E. C. R.	17,900	60	15.7	973	...	64.9	4.2	70.7
G. N. R.	19,900	58	15.9	1,082	9.6	65.8	5.2	83.0
F. R.	19,200	56	16.9	950	9.2	54.5	4.4	75.2
L. N. W. R.	15,500	60	14.3	857	9.5	63.4	5.0	86.0
M. R.	17,300	62½	13.8	865	8.8	71.4	5.0	76.5
G. N. R.	18,800	61½	16.7	1,027	9.2	63.2	4.6	76.4
	......	..	15.5	980	8.9	64.8	4.7	76.2

4-6-0 *Type*

					FBS			
Railway	R. T. E.	D	B	BD	St.	C	A	E
G. W. R.	25,200†	80½	11.7	945	7.2	79.0	5.2	80.1
G. W. R.	23,100	80½	10.7	866	7.2	79.0	5.2	73.0
N. E. R.	22,050	80¼	12.4	1,030	7.4	76.8	5.2	85.1
L. N. W. R.	18,600	75	9.3	682	6.7	79.8	5.8	73.2
L. N. W R.	23,600	62½	11.8	743	6.7	79.4	4.1	71.0
G. S. W. R.	20,600	78	11.1	864	7.5	69.0	5.6	81.7
L. S. W. R.	26,200	72	11.9	862	7.6	73.0	5.0	81.0
L. & Y	27,150	75	10.8	812	7.6	92.0	4.8	68.9
C. R.	20,200	78	8.9	696	6.5	87.0	6.0	73.3
	......	..	10.9	833	7.1	79.4	5.2	76.3
0-8-0 *Type*								
G. C. R.	28,600	53	16.2	860	...	71.0	4.9	80.2
C. R.	28,820	54	11.5	623	...	108.0	4.8	56.0
G. N. R.	26,850	56	18.7	1,069	9.2	58.7	4.5	85.0
N. E. R.	32,000	55	18.8	1,039	7.4	78.9	3.8	71.4
L. & Y.	29,400	54	15.3	829	7.6	83.0	4.4	68.0
H. & B.	29,600	54	15.8	858	7.4	84.8	4.6	73.8
	......	..	16.0	874	7.9	80.0	4.5	72.4

The factor C has been included because of its influence on the evaporative power of the heating surfaces, a discussion on which follows later. Table III from which the average values of B, BD and C have been taken, shows the variations of these factors in 45 different locomotives.

Table III shows that the characteristics of the individual locomotives vary somewhat, and an examination of the proportions of the locomotives of each type and a comparison of each particular type, forms an interesting study, both as showing the ideas of each designer when building a given type of engine, and also as showing the features of each type when type is compared with type, such comparison bringing into prominence the effects of the inherent features of locomotives having different wheel arrangements. The individual values of BD vary considerably, but the average values given in the summary II show a striking similarity—indicating that designers in general are agreed within fairly close limits as to the average speeds in revolutions per minute that locomotives should make under average conditions of service. The 4-4-0 type express locomotives appear in comparison with other engines to be deficient in heating surface; on the other hand, from a study of the heating surface distribution and the amount of grate area allowed per square foot of heating surface, it seems probable that the evaporation per square foot of heating surface will be relatively greater than with the other locomotives. The most generous allowance of heating surface in relation to the tractive effort is found as would be expected in the Atlantic type, as with this design heating surface is more readily attainable than adhesive weight.

Factor of Combustion, C

The value of this factor is of considerable importance as on it depends in a large measure the steaming capacity and economic performance of the boiler.

For a saturated steam locomotive the combustion factor is the total heating surface divided by the grate area.

For a boiler, however, which is fitted with a superheater the combustion factor should be expressed by adding the heating surface of the boiler to that of the superheater and dividing by the grate area, for it must not be forgotten that a portion of the heat generated on the fire grate goes to superheat the steam, and is not therefore available for evaporative purposes.

From a consideration of the above it would therefore seem that if locomotives using saturated and superheated steam are to be compared the factor C should be for saturated steam locomotives:

$$C = \frac{\text{Total Heating Surface}}{\text{Grate Area}}$$

and for superheater engines—

$$C = \frac{\text{Heating Surface plus Superheater Surface}}{\text{Grate Area}}$$

Factor of Firebox Volume

$$\text{Firebox Volume} = \frac{FBS}{GA}$$

Closely connected with the efficient combustion of fuel is the volume of the fire-box compared with the amount of coal fired. For the purpose of determining this comparison it is assumed that the grate surface will be a measure of the coal fired, and that the volume of different fire-boxes having equal grate areas will vary as the figure obtained by dividing the fire-box surface by the grate area.

Owing to the narrow and rather deep fire-boxes usual in

British practice little difficulty is experienced in obtaining a fairly considerable surface grate area ratio indicating a good fire-box volume.

In Table V,[*] which gives the comparative proportions of typical locomotives using saturated and superheated steam, the ratio of volume to grate area is shown in the column headed $\frac{F\,B\,S}{G\,A}$ and it will be noticed that both the 4-4-0 and 0-6-0 type engines have ratios of 6, and that the 4-4-2, 4-6-0 and 0-8-0 type each show somewhat lower figures. The reason for this is that in the former types the fire-boxes are usually deep, being often disposed between the driving and trailing axles, whilst in the latter types the fire-box is carried over the trailing axle and is thus shallower. Generally about 23 square feet is the limit for the grate surface if the box is between the driving and trailing axles; when larger the grate is sloped up over the rear axle, thus making it longer; the mean depth of the box is however less, and the surface grate area ratio is in consequence not so large.

Superheater Surface

$$\text{Ratio of Superheater Surface to Evaporative Surface} = \frac{Sh}{St}$$

This is expressed as a percentage of the total heating surface (St) of the boiler. From the tables of dimensions it will at once be noticed that the proportion of the total surface contained in the superheater seems to vary within somewhat wide limits, for instance, in Table 1—4-4-0 type locomotives this value ranges from 11.2 to 26.9 per cent. These differences are no doubt due largely to the different manner in which superheating surface is measured. Two superheater companies supply or control superheater equipment used, and they both seem to estimate on the steam contact surface. There are also certain other superheaters in use which have been developed on the railways using them, such as the "Horwich" superheater on the Lancashire and Yorkshire (L. & Y. R.), and the "Swindon" superheater used on the Great Western (G.W.R.) and the writer does not know how the surfaces are computed. Further—some locomotive engineers give the size of the superheating surface based on the fire contact areas, although they may use equipment specified by the superheater companies.

Factor of Efficiency of Design, E

$$E = \frac{\text{Total weight}}{\text{Total Heating Surface}}$$

and for locomotives fitted with superheaters

$$E = \frac{\text{Total weight}}{\text{Heating surface plus superheater surface}}$$

The idea of the factor E is to show the amount of weight expended per unit of power, it being assumed that the power available is proportional to the total heating surface, and at anything but the lowest speeds this is, broadly speaking, correct.

Exactly how superheated locomotives should be treated is largely a matter of opinion. As the factor E in the case of saturated steam locomotives is based on the total heating surface, it seems that superheated engines could conveniently be treated in the same manner, thus the boiler heating surface and that of the superheater would be added together and divided into the total engine weight expressed in pounds.

When saturated and superheated steam locomotives are to be compared having boilers of the same general dimensions, the value of the factor E for the superheated engine will be rather greater than for the saturated steam engine indicating a less efficient design, because the total heating surface of the boiler and superheater will be less than the total evaporative surface of the boiler without the superheater. In reality, the superheater fitted boiler will deliver the same or rather more power, so that when comparing superheater and non-superheater locomotives, the relative values of the heating surfaces must be taken into consideration. In British practice it may be taken that locomotives using saturated steam can develop a maintained output of 0.5 i.h.p. per square foot of total heating surface when running at about 240 r.p.m. and that locomotives fitted with superheaters will deliver a sustained output of about 0.65 i.h.p. per square foot of total surface in the boiler and superheater combined under similar conditions. The evaporative power and hence the power developed per square foot of heating surface can, however, be modified considerably, due to the disposition of the heating surfaces and the relative size of the grate and a discussion on this follows later.

For the various types of tank engines mentioned in Tables 2, 2A, 8, 9 and 10 the weight per square foot of heating surface has not been calculated for the reason that it would not give a factor E bearing any direct relation to the power of the engine as expressed by the extent of the heating surfaces because of the added weight due to the side tanks and bunker, and the various amounts of water and fuel carried.

The values of E' for the main line tender engines taken from Tables 1, 2, 3, 4, 4A, 5, 6, 7 and 8 are summarized as follows:

	Values of E		
Engine type	Max.	Min.	Average
4-4-0	97.5	72.2	82.7
4-4-2	95.0	60.2	77.3
4-6-0	86.8	66.9	75.7
2-6-0	103	69.6	82.0
2-8-0	80.5	64.3	74.9
0-8-0	84.8	60.0	68.6
0-6-0	93.4	66.8	80.0
0-10-0	....	....	76.0

From a study of the tables of proportions it will be noticed that those designs which have the larger heating surfaces weigh less per square foot of heating surface that those having smaller amounts of heating surface, and that this feature holds good for all types. This fact must not be lost sight of when estimating the weight of a proposed design and using the average factors of E.

(*To be continued.*)

Properties of Oils for Lubricating Air Compressors[*]

In lubricating the cylinder of an air compressor, we must use an oil that is viscous enough to resist the tendency of the piston to wipe it off and leave the metal surface dry; but the viscosity should not be great enough to offer any considerable opposition to the motion of the piston. We must remember, in other words, that lubrication is intended to diminish friction, as well as to seal the piston so that air cannot leak around it. The errors that are made in selecting oils for lubricating air-compressor cylinders probably tend toward a viscosity that is too high instead of too low. The Compressed Air Society has prepared a paper dealing with this subject quite fully. The average viscosity given therein as corresponding with good practice ranges from 230 to 315 seconds on the Saybolt scale for paraffin-base oils, and from 275 to 325 for asphaltic-base oils. The *minimum* limits for viscosity in good practice are given as 120 S. for paraffin-base oils and 175 S. for asphaltic-base oils.

The average density for good practice is given as 25° to 30° Baumé for paraffin-base oils, with a minimum of 32° and a maximum of 25°; and as 19.8° to 21° Baumé for asphaltic-base oils, with a minimum of 22° and a maximum of 19.5°. (Higher readings correspond to lighter oils.)

In connection with flash-point tests (as made by the open-cup apparatus), this same paper recommends 400° to 425° Fahr. as good average practice for paraffin-base oils, and 315° to 335° Fahr. for asphaltic-base oils—the fire test being higher than the flash point by about 50° in the paraffin-base oils, and by from 55° to 65° in the asphaltic-base oils.

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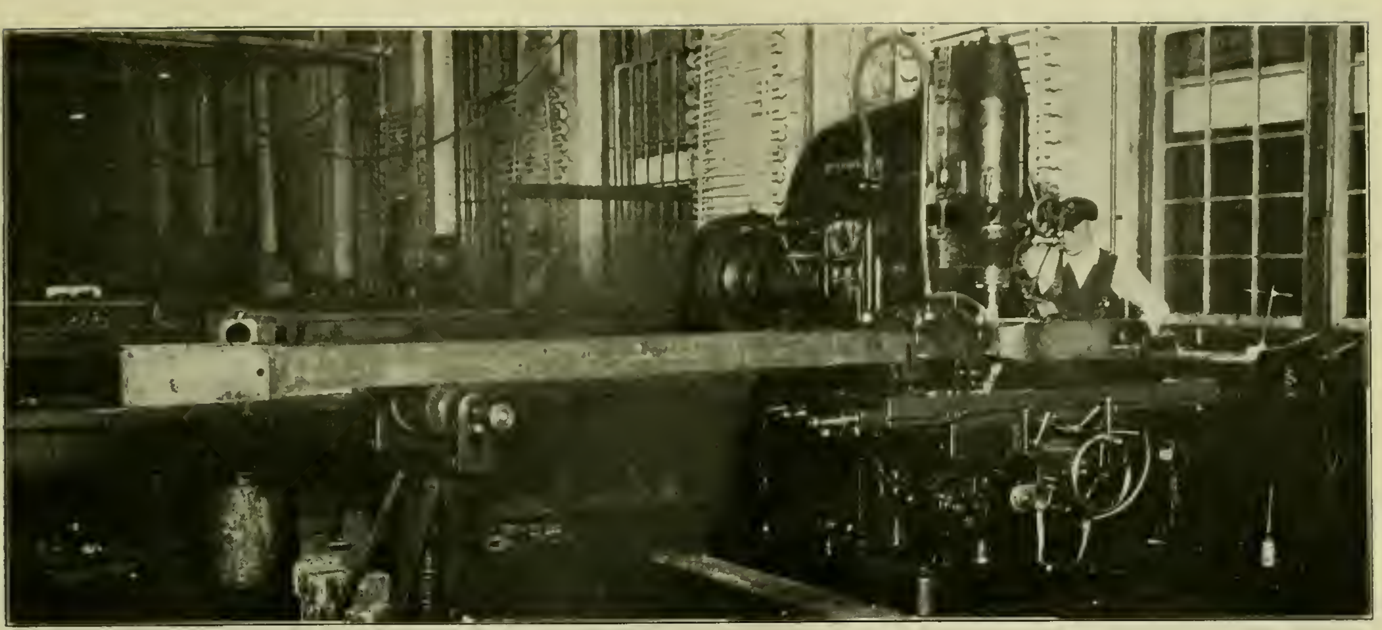
[*] Owing to lack of space some of the tables have been omitted but will appear in the next issue.

[†] From an address delivered by A. D. Risteen before the Engineering Section of the National Safety Council, in Philadelphia.



Vertical Spindle Milling Machine Truing Brass Fit in Main Rod Jaws

Speeding Up Locomotive Main Rod Repairs

Rod Jaws and Brasses Should Be Accurately Machined to Eliminate as Much Hand Filing and Fitting as Possible

BY M. H. WILLIAMS

MAIN rods used on modern locomotives are so large that, when being repaired, it is laborious work to file the jaws and sides and make these surfaces true as they should be in order to properly hold the brasses. Likewise, the heavy brasses are difficult to file and handle from the vise to the rod for trial fittings. To minimize manual labor and secure greater accuracy, the work of finishing rod jaws in some railway shops is now done by machinery, resulting in the practical elimination of filing. The brasses also are machined to the proper size to fit the rods and require practically no hand fitting.

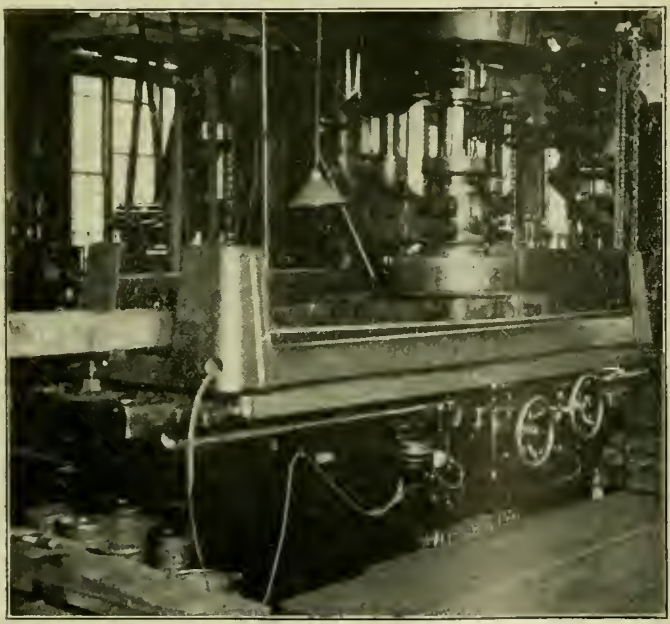


Fig. 1—Surface Grinder Used in Finishing Main Rod Sides

Doing this work by machinery may appear difficult, owing to the fact that almost no two rods coming in for repairs are exactly alike. There are slight differences in thicknesses and widths, owing to wear, previous repairs and other causes but this difficulty has been overcome in shops where the problem has received careful consideration. The methods and machinery described below are used successfully in a number of large railroad shops.

Finishing the Sides of Rods

For finishing the sides of main rods, removing irregularities and insuring that the two sides are parallel, a surface grinder can best be used. This machine should preferably be of the vertical-spindle type on account of greater ease in securing rods to the table. A rugged design having the necessary weight and strength to remove metal rapidly also is necessary. The diameter of the grinding wheel should preferably be equal to or greater than the widest part of the rods or parts to be finished in order to finish the surfaces without resetting. A good example of a grinding machine adapted for this purpose is the 22 in. by 7 ft. model shown in Fig. 1. This should be equipped with a magnetic chuck in order to admit of quickly clamping and holding the rods.

To prepare a rod for grinding the sides, the brasses are removed, after which the wedges, blocks and straps are replaced. This enables the rod and auxiliary parts all to be ground at one time, insuring that they will be of equal thickness. The rod is now placed on the surface grinder and held by the magnetic chuck with the outer end properly blocked on the machine table. One side of the rod is ground just enough to remove the depressions and rough places and make a suitable side bearing for the brasses. Generally speaking, only a small amount of material need be removed and the rod can then be ground in a similar manner on the opposite side. After the completion of one end, the opposite end also is ground. This insures that the two sides of the rod are parallel and of uniform thickness; also the wedges and other parts will be finished flush with the sides of the rod, a desirable feature, rarely accomplished where rods are filed. After the completion of the grinding operation the wedges and blocks are removed and the rod is ready for the milling operation.

Milling Worn Rod Jaws

The operation of removing irregularities and truing up rod or strap jaws where the brasses fit can readily be performed on a vertical milling machine, a representative machine suitable for this purpose being shown in the illustration at the beginning of this article. The vertical-spindle machine is preferred on account of greater ease in clamping rods to the table and the fact that the milling operation will be in plain sight; also it is not necessary to lift or lower the rod during the milling as would be the case with a horizontal form of milling machine. As in the case of the grinder, heavy construction is necessary in order to support the weight of the rod and guard against the table binding, causing it to work hard during the milling operation.

The operation of milling a rod, as performed in one of the larger railway shops, is shown in Fig. 2. It will be noticed that the rod is held on the milling machine table by two clamps. Arrangements are made for easy leveling by means of two adjustable taper wedges on which the rod rests. The part of the rod extending past the table is held on a trestle, adjustable vertically by means of a screw and also provided with a spring to compensate for slight irregularities in the rods.

When placing a rod in the machine the following plan is followed. The rod is placed in the two clamps with the outer end resting on the trestle. The trestle is then adjusted to support about one-half the weight of the rod, side adjusting screws being tightened to locate the rod on the center line with the machine table. For rough adjusting, the operator sights along the rod and table, but for more accurate work, the rod is lined with a surface gage making use of the side of the table for guiding the surface gage.

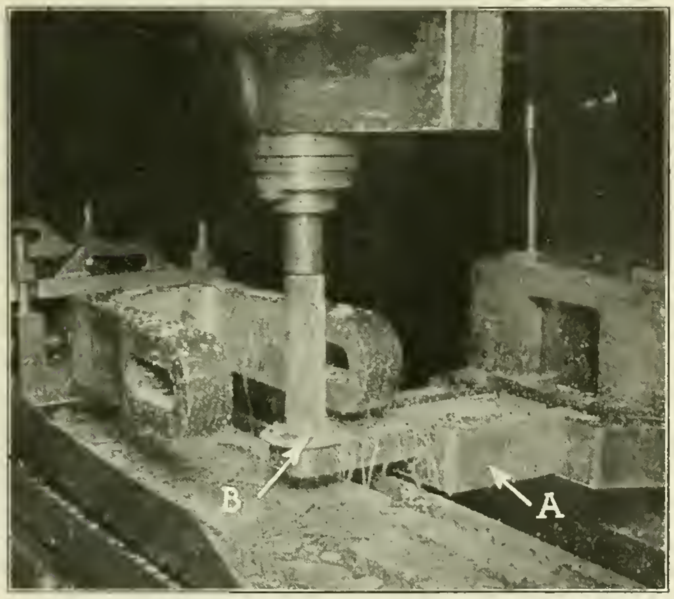


Fig. 2—Completion of Rod Milling Operation

In order to insure the rod being set so that the top surface of the jaws will be parallel to the machine table, a spirit level is placed on the top of the rod jaw. The wedges of both clamps are adjusted in or out as may be necessary until the rod is properly leveled. The hold-down clamps are now placed in position and tightened. If, as a result of tightening these clamps, the rod is thrown out of level, the hold-down clamps are loosened and the wedges again adjusted, after which all the holding bolts are tightened.

A milling cutter suitable for this work is shown in Fig. 2, being made about 1 in. longer than the width of the largest rod handled. The diameter is the same as the fillet in the jaws and as many cutters must be provided as there are different sized fillets. These cutters are generally cut to about a 45 deg. spiral in order to insure a smooth cut, the larger or 2-in. cutters having three teeth and the smaller two teeth. The teeth in order to cut properly have a 6 deg. front rake on the front cutting edges. A pilot or extension is also made on each cutter to be a running fit in a bushing held in a support from the machine. The cutters must of necessity be small in diameter as compared to their length and for this reason are supported at the outer or lower end in order to prevent springing. For this support a special fixture shown at *A* Fig. 3 is used and held on the machine above the knee. The cutter pilot fits a bushing or preferably a ball bearing held in this support. In order to prevent chips entering the lower support, a deflector *B* is placed on the cutter and revolves with the cutter, throwing the chips outward by centrifugal force.

Fig. 3—Shaper and Fixture for Machining Back End Brasses

The completion of a milling operation is shown in Fig. 2. When milling, the practice is to set the cutter to the proper depth to just true up one side of the jaw. After the cutter depth is properly set, the power feed is thrown in and one side milled to the fillet. The power feed is then thrown out and the cutter fed by hand into the fillet. After this is completed the table cross-feed is thrown in and the back end of the jaw milled in a like manner. A similar practice is followed for all surfaces of the jaw that require truing up.

During the milling operation care is taken to feed the cutter in only deep enough to remove the high spots so that the rod is not enlarged any more than necessary. In fact, it is often customary to leave small spots, often called proof marks. The rod or straps after the milling operation are ready for fitting the brasses and, with the possible exception of removing burrs, no filing is required.

On account of the accuracy of the average milling machine, the sides and ends of the milled jaws are made square with each other and will be much superior to the average filing job. As the cutters used for this purpose are small in diameter they are run at a high rate of speed, generally as high as 150 r.p.m. for the 1-in. and 100 r.p.m. for the 2-in. cutters. As the cuts are light the feed can be quite rapid and may be from ½ in. to 3 in. per min., depending on the depth of cut and smoothness demanded. This rate of feed and the length to be milled will serve for the purpose of estimating the time required for the actual milling operation.

As to precautions necessary in order to obtain good work: the cutters being small in diameter must be well supported at the lower end in the bearing; also when ground they must be of one diameter from end to end, and unless this is the case errors in cutter grinding will be reflected in the squareness of the milled surfaces. The front end jaws or the straps where used on the rear ends of main rods, are milled as explained, making use of the same holding fixture.

The above method of machining these rod jaws does not present any difficulties that cannot be overcome by the average shop force. Changing from filing to milling will require time in order properly to instruct the workmen on such a new departure, but this milling operation is no more difficult than the average milling machine work.

Machining Back End Rod Brasses

The question of machining back end brasses will be considered first and in order to lead up to what may be called the most modern practices a brief reference to past methods will be made. The most common practice has been to rough out brasses on a planer where they are held in one or more rows of 8 to 15 brasses, clamped to an angle plate. Objections to this method are the relatively long time required to set up and machine the brasses and the fact that they are all standard and require subsequent individual machining, filing and fitting. A better way is to rough out and finish one set of brasses at a time on a crank planer or shaper, using an indexing fixture, as shown in Fig. 3. The angle plate of this fixture is bolted to the machine table, a pair of brasses being held on the plate by a central bolt, outside plate and set screws. Eight accurately spaced index holes are drilled in the angle plate and enable the brass to be quickly and accurately revolved to any 45 or 90 deg. position. With a well-made fixture of this design, brasses are machined in some shops so accurately that they are a satisfactory fit in the rod, and no filing is necessary except to remove burrs.

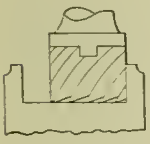


Fig. 4

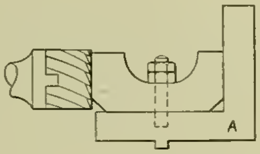


Fig. 5

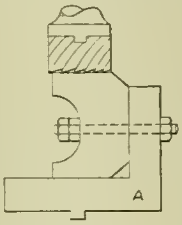


Fig. 6

The detailed operation follows: the distance between jaws of rods is carefully measured with inside micrometer calipers; the thickness of the rod where the brasses fit is also measured with outside micrometer calipers, these sizes being recorded on blanks or memorandums. When machining, the brasses are first gone over for the roughing out operation allowing the usual amount for finishing. The surfaces that are to fit inside of the rod jaws are finished to the same dimensions as the space between the jaws; that is, one surface is smoothed up and the second side measured from the first. This dimension must be correct and is measured with great care with outside micrometers. The front and back surfaces are then planed with reasonable care, the clearance for the fillets being machined by indexing the fixture on the 45 deg. holes. About .008 in. is allowed for clearance between the brass flanges and the rod jaws.

Brasses are also milled to the correct size to fit the rod from the rough casting or when making use of brasses that have been previously roughed out on a planer as explained. The operation of milling is performed in a satisfactory manner on the vertical type machine illustrated, the castings being held in a fixture similar to that shown in Fig. 3. The general sequence of operations is similar to that used with the crank planer or shaper. Where the milling machine is used, the milling cutter is adjusted to mill the surface of one flange. The micrometer dial on the machine is then set to the zero mark, the machine table being raised to the proper height to mill the top surface and a cut taken. The table is then set over so that the return cut will mill a space that will be the required distance between flanges. For this operation it is necessary to carefully measure the distance between flanges in order that they shall be of the width required. When the proper distance has once been made correct, the position of the micrometer dial is noted and recorded for use when milling the remaining flanges. The fixture is then indexed to the next quarter and the end surface finished. When milling this surface, and in fact, all the remaining surfaces, the first cut is taken with the micrometer dial set on the zero and the return cut with the dial set to the same place as the previous milling. The third side is now milled, when it is necessary to measure the distances between the two surfaces which fit between the rod jaws. This is done, as has been explained in connection with the planing operation. The remaining end and the clearances for fillets are now milled in a similar manner. For this milling operation the cutters must have a diameter about two-thirds the distance between flanges and of length about equal to the greatest depth of flange as illustrated in Fig. 4.

Milling has several advantages as compared with planing: the surfaces will be much smoother than where planed and by using the micrometer dials on the machine, the distances are set so that one setting does for all of the flanges of a single set of brasses; also the time for doing the work is less than planing. This milling work is also done on horizontal knee type machines in which event the brass is held in a circular milling attachment similar to that shown in Fig. 3, only set on its side. In some cases the regular circular milling attachment such as supplied by milling machine makers is used. The main advantage of the vertical spindle machine is due to the operator having a better view of the progress of the work.

The advisability of milling brasses from the rough castings will be governed largely by the grade of brass or bronze used. With a free cutting metal they may be milled economically. However, with some grades of bronze, the wear of cutters is so great that the cost of their upkeep outweighs any possible saving as compared with planing or shaping. Where the brasses are first roughed out and the outside scale removed, the life of the cutters between grindings will be much greater and, in this case, the operation of milling to fit rods may be done economically.

Machining Front End Brasses

Machining front end brasses to fit the rods is a comparatively simple operation. In most cases their horizontal length is not of enough importance to require separate machining for each individual pair and for that reason they are roughed out in quantities, allowing extra metal only on the top and bottom surfaces to admit of finishing to fit the varying sizes of rods. This work is often done on a planer.

When finishing to fit the rod, a horizontal type milling machine, shaper, or crank planer may be employed, the brasses being held in fixtures as shown in Fig. 5 and 6. These two fixtures are quite similar, being made up of an angle plate with a tongue fitting the machine table. The length of the angle plate is less than the width of the shortest brass handled, in order that one end may extend past the fixture for the purpose of calipering. The rod brass is held in place by two bolts and a clamp as shown.

The operation of measuring and machining these parts is as follows: The rod jaws are carefully measured with inside micrometer calipers and the size recorded. The brasses are placed in the fixture one-half at a time and firmly clamped. The surface to be fitted is then carefully machined to the required size which will be practically the size of the rod jaws. This size of the brasses is measured with outside micrometers. The second half is machined in a similar manner. This is not a difficult machining operation and where reasonable care is exercised, the brasses will be a neat drive fit in the rods.

Comparison of Machine and Hand Fitting

It would be well at this point to consider the pros and cons of this method of machine fitting as compared with roughing out, filing and fitting by the cut and dry methods. It goes without saying that the brasses both front and rear should be a light drive fit, and also have true surfaces in order to present a good bearing in the rod and not work loose. In order to obtain the close fitting demanded, any method will require close measurements and machining. If this be done by filing, the rod and brasses each must be calipered several times, or several trial fittings must be made of the brasses, all of which takes time. Also filing a rod brass perfectly square and flat so that it will compare with planing or milling is a job that can be done only by an expert.

Where the rods are repaired on the milling machines and grinder as explained, the surfaces fitting the rod brasses will be true and square. This reduces the work of fitting the brasses very materially. In order to insure a brass fitting at first trial it is necessary to measure the rod and brass very carefully, which for a person not experienced in this line of work will consume time. However, where this practice is followed, the men become expert in measuring so that but a small amount of time is required. By this method the micrometer measurements serve the same purpose as several trials of the brass in the rod where the older plan is followed. Micrometers are much easier and quicker to handle than a rod brass and as a result the laborious work is greatly reduced.

Fuel Accounting*

It is the recommendation of the committee that fuel accounting be handled by the auditing department. This does not affect separate organizations or departments which handle the purchase, inspection, nor use of fuel. Every railroad engaged in interstate commerce is guided in its final accounts by certain rules and regulations laid down by the Interstate Commerce Commission. The accounting department of every railroad understands these regulations and knows how to meet the requirements with regard to the allocation of fuel charges to operating expenses. Therefore, all forms used in connection with fuel accounting, are designed to meet these ends.

After the general purchasing agent has arranged contracts for delivery of coal, a mine manifest should be rendered daily to cover all coal shipped, showing destination, waybill reference, kind of coal, car number and initial, and gross, tare and net weights, one copy going to the fuel supervisor and one to car service department or the party handling the distribution of coal The coal contractor should forward to general purchasing agent an invoice for all coal shipped, who will approve as to price, etc., and pass to the accounting department.

After arriving at distributing or junction point, a diversion report is compiled for the party handling distribution, showing car number and initial, original waybill reference, point to which diverted, shipper, and to whom and why diverted.

After the coal has arrived at the unloading station, the coal dock foreman must inform the fuelkeeper of the amount of coal received and unloaded so that he can render a daily report to the accounting department, with copy to the fuel supervisor; the accounting department to check receipt against invoice before passing for payment. The coal tickets covering issues to locomotives are handled by the coal dock foreman and passed to the fuelkeeper each day. The form for reporting coal received and unloaded provides for showing the waybill reference, the weight of the coal, and the amount unloaded is carried forward from day to day so that the report at the end of the month will show the total amount of coal delivered to locomotives, or otherwise charged out at the station where unloaded. There should be a place provided on the reverse side of the daily unloading report for showing all cars on hand not unloaded. From this and the diversion reports information to locate every car is available.

As coal is generally put through chutes with no weighing device and as estimates of issues to individual locomotives necessarily follow, some adjustments will be required to balance with the inventory. A ten day or shorter period trial balance is therefore the solution in order to correct discrepancies before they become thirty days old, rendering the adjustments so heavy that the accuracy of charges to the individual locomotives and classes of service might be questioned.

Coal spilled at chutes should be picked up every day, if possible, and put back into the chute. If it is not possible to do this with some type of chutes, it should be done at least as often as trial or regular balance is taken, so that the report at the end of the month would show a balance requiring minimum adjustments.

A careful record should be kept of coal issued, and to do this it is necessary to keep before the fuelkeeper a working sheet on which the days of the month are shown, with headings covering every known use of fuel, on which fuelkeeper should be required to show distribution every day, so that at the end of the month the various items may be added and made ready for the balance sheet.

The balance sheet should provide a place for showing inventory and coal received and disbursed for all purposes. This report, with the tickets supporting the issues to locomotives, should be forwarded to the auditing department promptly after the close of each month, but only after the fuelkeeper has checked the agent's record to see that he has accounted for every car of coal reported by the agent to the auditor of freight accounts as being unloaded at his station.

To avoid omitting in the report of fuel received the cars under load at the closing period, it is essential that a record be maintained of cars received but not unloaded.

For distribution of fuel to locomotives, a separate form should be used which will show allocation of fuel to each individual locomotive, subdivided as between various classes of service in which the locomotive may make mileage. The form should accompany the balance sheet and will permit the auditing department to make proper charge of fuel to every locomotive.

Fuel oil, which is in general use on many of the western and southwestern roads, should be accounted for under the same basic principles as outlined above.

The report is signed by J. N. Clark (Sou. Pac.), Chairman; R. R. Hibben (M. K. & T.); R. E. Jones (D. & I. R.); C. F. Ludington (Crescent Coal Co.); Joseph McCabe (N. Y., N. H. & H.); Hugh McVeagh (Big Four); C. F. Needham (Grand Trunk); H. E. Ray (A., T. & S. F.), and W. J. Tapp (D. & R. G. W.).

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*From the report of the committee on Fuel Accounting presented at the 1921 convention of the International Railway Fuel Association.

Insulation of Passenger and Refrigerator Cars

A Discussion of the Principles Involved in Determining Heat Transmission Under Various Conditions

BY ARTHUR J. WOOD

WITH the introduction of steel postal cars, the railroads found themselves face to face with the seemingly simple problem of determining whether an insulated car section met certain specified requirements for the amount of heat flowing through a wall section. In order to determine the heat transmitted through a duplicate section or blank similar to one cut from the wall of a car, the Post Office Department specified that the blanks be tested in a new box calorimeter, commonly known as the Postal Text Box. This calorimeter is not a scientifically constructed apparatus, but it has been used in a number of laboratories for determining approximately certain constants.

The specifications stated that the minimum requirement for acceptance of the insulation should be based on a certain amount of heat flow between the inside and outside walls of the section. Since no method was provided for determining the temperatures of the wall surfaces, it has been interpreted to mean that total transmission (which includes the two surface transmissions), and not conduction of the compound wall, was the intent of the specification. The writer has pointed out as a result of extended tests* that the Postal Box when used as directed, is unreliable for even approximate results and the Railway Age Gazette** suggested editorially, that the specifications should be revised.

There are four outstanding sources of error in this box: (1) use of mercury thermometers, (2) radiation from the exposed heating wires, (3) placing the blanks too close (3 in.) together, (4) uncertainty in determining the area through which the heat flows. This last mentioned source of error is in itself sufficient to condemn its use for car sections with an air space, even if the blanks are placed flush and temperature measurements are made properly.

A more accurate determination may be made by calculating the heat transmission (if the conductivity of each material used is known) than can be found by inserting blanks of a car section in the Postal Test Box.

The study of heat transmission is by no means simple, and one should approach the subject with full appreciation of the factors involved. The laws of conduction, convection and radiation, the various influences affecting surface transmission, the significance of air space construction, together with a knowledge of right method of testing, should form the basis of a study of the subject. Sometimes, approximate methods will answer the immediate need of the engineer, but this is hardly true of the subject of heat transmission. It is of first importance to know the extent of probable errors involved in any methods employed, and this is occupying much of our attention at the Thermal Plant of the Pennsylvania State College. It is apparently an easy matter to make tests in heat transmission and determine new constants for insulating and building materials. This has been done to such an extent that engineers have been confused rather than helped, because the methods employed were not fully stated or were not based on a scientific study of the problem.

Mr. Allman's Paper

The article by Wm. N. Allman in your issue of July, 1921, contains many points which may well be studied by those who desire to apply the theory to practical problems; however, his treatment of the subject is not altogether satisfying.

1. Table III, Page 447, Thermal Conduction in Air Spaces, may be confusing in two particulars,

(a) The values under C and K should be transposed. C should equal the B.t.u. for the thickness given in the first column and K the B.t.u. for one inch thickness. This typographical error has been handed down from the original paper by Dickinson and Van Dusen as printed in the Journal of American Society of Refrigerating Engineers, September, 1916.

(b) For all practical purposes the value of K may be omitted from the table, for it may readily be misinterpreted. For two temperature differences, Table III as given by Mr. Allman would read as follows:

TABLE 1—THERMAL CONDUCTION B.T.U. PER 24-HR. OF VERTICAL AIR SPACES 8 IN. HIGH.

Width of spaces, in.	Temp. diff. 18 deg. F.	Temp. diff. 45 deg. F.
	C	C
⅛	50	53
¼	32	34
⅜	26	28
½	23	25
⅝	22	25
¾	22	26
⅞	22	26
1	22	26
	Air Spaces 24 in. High	
½	22.0	24
1	19.1	23
2	18.4	23
3	18.7	22

Corrections for radiation in the above values may be made by applying the law of Stefan and Bolzmann with the proper constants. Also, to use the table accurately, one must know from test or from calculation the probable temperature drop through the air space. A value of 1, the conduction per hour, for spaces ½ in. and over in width, is a safe approximate value.

2. Does an air space in the wall of a steel postal or refrigerator car remain a dead air space for a considerable length of time? Probably not, and yet some break in the insulation as usually inserted, would not entirely offset the good effects of the insulation unless there was a current of air through the space. In general, it is better to insert insulation in such spaces. Before one can answer many of the questions about the effectiveness of air space insulation in refrigerator cars, we should have accurate information about the conditions before and after cars have been in service.

If the 3½ in. air space, Fig. 2, was divided up by building paper into three air spaces, each approximately 1⅛ in. in width, there would be added four additional surface resistances and two additional air spaces and the conduction of the total air spaces would be about ¼ that given for the one space. A calculation is later made to show the effect of such arrangement on the total transmission.

Tests on air spaces of different construction show the following results:*

TABLE II—CONDUCTION PER DEGREE F. THROUGH AIR SPACES, AT 18 DEG. F. TEMPERATURE DIFFERENCE.

	C Conduction; outer surface to outer surface.
Three ½" air spaces	0.286
Three 1" air spaces	0.219
Three 1½" air spaces	0.183

In our air space tests, three cubical boxes were constructed

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*A.S.R.E. Journal, Jan., 1918: Bulletin No. 30, Eng. Exp. Station, The Pennsylvania State College.

**Railway Age Gazette, December 22, 1916.

*Derived from values given in Bulletin No. 30, "Heat Transmission; Corkboard and Air Spaces," by A. J. Wood and E. F. Grundhofer.

about a cubical heating element, the boxes being built up in thickness of 1½ in., 1 in. and ½ in. respectively. The results show that by taking three 1½ in. air spaces to represent an insulating value of 100 per cent, three 1 in. air spaces represent an insulating value of 84 per cent, and three ½ in. air spaces represent an insulating value of 64 per cent, these values being based on conduction.

Tests on ½ in. air spaces 7½ in. high, gave the following values: If three air spaces ½ in. each in thickness represent an insulating value of 100 per cent, then two ½ in. each represent an insulating value of 79 per cent and one air space ½ in. thick represents an insulating value of 59 per cent, based on total temperature difference, outside to outside.

3. *Surface Transmission.* Mr. Allman states that it is safe to assume a surface conductivity in still air of 2 B.t.u. per square foot, but he avoids using any value for the outside surface and does not explain why this term is omitted. The above value is on the safe side for one surface, but is higher than we have found recently at our Thermal Plant of the Pennsylvania State College for the ordinary insulating and building materials subjected to natural convection. The value of K varies from .9 to 2.0 for one side of a surface and for materials of different character. The average value from twenty tests on corkboard for ranges of different temperature differences from 30 to 70 deg. F., gives 1.1 B.t.u. per hour for the constant. For a smooth surface exposed to some air movement the writer uses 1.5. It is not important to know very accurately the value for surface transmission in the case of good insulation, but it becomes more and more the determining factor as the combined conduction of the materials used in a structure becomes greater.

But what is its value for the outside surface of a car, subjected to high velocities? There is one assumption on the safe side, at least until more data is at hand, and that is to take the temperature of the surface equal to that of the air; in other words, to assume that the heat is brushed off the surface as rapidly as it passes to the surface. This will give a value of outside surface transmission equal to zero. I determined the values from which the curves in Fig. 1 in Mr. Allman's paper was plotted, on a five-foot square insulated postal car section with air passing over the surface parallel to the blank, and this gave a multiplier of 2.3 for an air velocity of 20 m.p.h.; that is, the amount of heat transmitted was 2.3 times that obtained under still air conditions. When it is necessary to use a multiplier for high velocities, I would recommend the value of 3.

Exactly how is the heat conducted away from a surface? This is an interesting question to many and offers the basis for further analysis. In Fig. 1, is reproduced a curve from the center of a 2 ft. square blank of corkboard 1 in. thick, in still air. It will be observed that readings were taken by about 1/16 in. intervals close to the surface and then further apart as the distance from the surface becomes greater. The drop in temperature is rapid during the first inch, and at two inches from the surface the room temperature has nearly been reached. Half of the total drop occurs within ¼ in. from the surface.

One of the purposes of obtaining the surface gradients is to study the effect of convection currents, for these changes in temperature are due to the natural movement of air caused by the absorption of heat along the face of the plate, corresponding to the conditions of the outside wall of a car in still air. In most cases of thicker insulation, as here shown, the average outside temperature will not be reached for two feet or more. It is therefore important to note carefully where the outside temperature is observed.

To obtain the outside coefficient (K_2) of surface transmission in Fig. 1,

$H = K_2 (T_1 - T_2)$, where

H is the heat flow per sq. ft.,

T_1 is the temperature of the surface and

T_2 the temperature of the air passing to the lower surface of the plate,

$10.185 = K_2 (45.5 - 34.6)$.

$K_2 = .93$ B.t.u. per deg. F. difference.

The heat resisting or insulating value of this surface would be equivalent to that of ⅓ in. corkboard, which is the value for the conditions of this test and is approximately true for the average condition of good insulation.

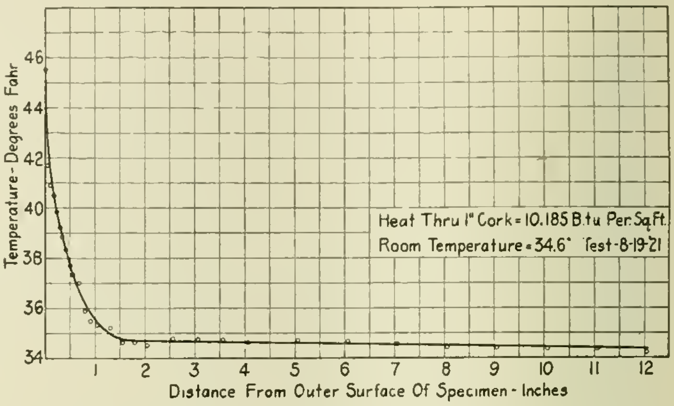


Fig. 1—Surface Gradient of a Corkboard Blank—Natural Convection

In this test one-half the total temperature drop occurred within ¼ in. from the surface. This brings out the importance of the air near the surface influencing heat transmission.

Not much of value has been added to our knowledge of surface transmission since the classic researches of Peclet published in 1829, and the later work of Grashof and Rietschel. The accurate determination of surface effects calls for refined methods of measuring heat flow and temperatures. At the Thermal Plant of the Pennsylvania State College, we are extending our previous work with greater accuracy. The new test plate which is 3 ft. square, including the guard ring, may be used in a constant temperature room for determining, at the same time, both surface transmission and conduction. One distinct advantage of this plate over the box method of testing is apparent in the case of testing high temperature insulation, as boiler lagging in locomotives; the temperature and heating conditions can be made similar to those on the boiler.

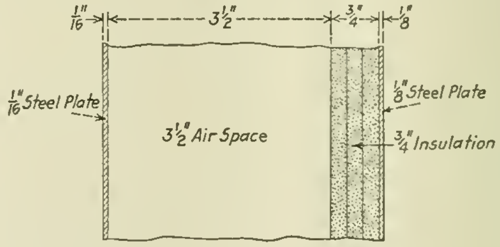


Fig. 2—Representative Section of Steel Passenger Car Wall

4. *Constants.* Mr. Allman gives in his Table IV, values for many materials from tests by the Union Pacific in 1914. Unfortunately he does not state how these constants for heat transmission were determined. Are the values for conductivity or for total heat transmission (which includes the surface effects)? He uses them in his equation as if they were conductivity but they are total transmission values if obtained by the Postal Box as designed and used according to the instructions, or by any method where surface temperatures were not observed. While the results of some of the materials check fairly well with later accepted values, these tests do not bear the marks of results from a scientific investigation. The values should not be accepted, at least not

until the methods by which they were obtained are fully stated. In the table "weight per sq. ft." evidently refers to the weight in ounces for the thickness given and the B.t.u. per sq. ft. per deg. F. difference in temperature per 24 hrs., is evidently per inch thickness, and not for the thickness of the test blank. This is inferred from values such as for "Headlining" where it gives a value for ¼ in. thickness as 15.816 B.t.u. per 24 hr., and the next line gives 14.328 B.t.u. for 31/32 in. thickness. Mr. Allman uses the value for 3-ply salamander as if the table gave the value for conductivity for ¾ in. instead of per inch.

The table for thermal conductivity as determined by the Bureau of Standards by the plate method, and which is given in his Table II, page 445, is unquestionably the most trustworthy recent table of constants for conduction for materials used in car and other temperature insulation.

5. *Calculations.* Fig. 2 is the same as used by Mr. Allman and is reproduced to examine into different methods of calculation. Mr. Allman calculates the total transmission H per hour for 1 deg. F. difference, between the inside and outside temperatures, from the general equation for a compound wall;

$$H = \frac{1}{\frac{1}{K_1} + \frac{d}{c} + \frac{d_1}{c_1} + \frac{d_2}{c_2} + \text{etc.} + \frac{1}{K_2}}, \text{ where}$$

K_1 = Inner surface conduction.
K_2 = Outer surface conduction.
d, d_1, d_2, etc. = Thickness of each element in wall.
c, c_1, c_2, etc. = Thermal conductivity (per hour) of elements corresponding to thickness d, d_1, d_2, etc. per inch thickness per sq. ft. per deg. F.

Mr. Allman uses but one value for surface resistance which he calls $\frac{1}{K}$, but does not state if this is for one or for two surfaces. When the formula is to apply to total temperature difference between inside (T_1) and outside (T_2) temperatures, the above formula should be multiplied by ($T_1 - T_2$).

For Fig. 2:

$$H = \frac{1}{\underset{\text{surface}}{\tfrac{1}{2}} + \underset{\text{steel}}{\frac{.125}{322}} + \underset{\text{salamander}}{\frac{.75}{.2055}} + \underset{\text{air}}{1} + \underset{\text{steel}}{\frac{.0625}{322}}}$$

= .194 B.t.u. per hr. per sq. ft. per in. thickness per deg. F difference in temperature,
or 4.656 B.t.u. per 24 hrs..........................(1)
which he states is well within the figure 8 B.t.u. as stipulated by the Post Office Department. For all practical purposes the effect of conductivity of the steel plates may be omitted, as they would change the final values only about ¼ of one per cent, so that the second and fifth terms in the denominator will disappear. The value for salamander from the Union Pacific table would be .274 B.t.u. per *inch* if the table gives conductivity (and if it is correctly determined), but as pointed out, this table evidently gives total transmission and the probable value of its conductivity figures to be .466. We will first omit the value for the air space on the assumption that it is not a dead air space, giving for the heat transmission, H, for Fig. 2:

$$H = \frac{1}{\underset{\text{inner surface}}{\frac{1}{1.5}} + \underset{\text{salamander}}{\frac{.75}{.466}}} = \frac{1}{1.297} = .435 \text{ B.t.u. per hr.}$$

or 10.4 B.t.u. per 24 hrs..........................(2)
which is not within the limits specified.

If the air space is included and its value taken as 1

$$H = \frac{1}{\frac{1}{1.5} + \frac{.75}{.466} + 1} = .305 \text{ B.t.u. per hr.}$$

or 7.32 B.t.u. per 24 hrs..........................(3)
which safely falls within the limits.

If the air space was filled with mineral wool, or an equally good insulation, the probable total transmission would be:

$$H = \frac{1}{\frac{1}{1.5} + \frac{.75}{.466} + \frac{3.5}{.288}} = .068 \text{ B.t.u. per hr.}$$

or 1.63 B.t.u. per 24 hrs..........................(4)

If the air spaces had been divided up by building paper into three air spaces of approximately 1 in. thick each (see Table II), the total transmission would be:

$$H = \frac{1}{\frac{1}{1.5} + \frac{.75}{.466} + \frac{1}{.219}} = .147 \text{ B.t.u. per hr.}$$

or 3.528 B.t.u. per 24 hrs..........................(5)

If the specifications are interpreted literally and the amount of heat transmitted is measured between the inside and outside walls, the term $\frac{1}{1.5}$ would be omitted from Equation 3, giving 9.19 B.t.u. per 24 hrs. The writer believes this to be the rational method of specifying the requirements in a car section.

The same methods as applied to Fig. 2 may be applied to a refrigerator car section and anyone may figure for himself the probable heat transmission through a compound wall.

The above calculations do not go into questions of heat transmitted through braces, struts and rigid members of a structure which require a separate analysis, aside from the purpose of this paper.

The several methods of applying the general formula are presented to indicate (1) the necessity for knowing the condition of the structure and (2) the function of a dead air space compared with the same space filled with a good insulator.

Further Investigations. More extended scientific investigations are needed on the following projects in order to assist in the better design of insulated walls. The railroads are directly concerned with research work along these lines:

1. Surface transmission in still air.
2. Surface transmission in moving air.
3. Surface transmission as affected by humidity and by rain.
4. Conduction as affected by moisture.
5. Effect of radiation as a correction factor.
6. Heat transmission of walls in place.
7. Influence of struts in a compound wall.

Women Employees in Railroad Service.—The classification of women employees of Class I roads for the year 1920, shows that female employees are engaged in many different classes of service. In the shops, there are small numbers listed as blacksmiths' helpers, boiler makers' helpers, machinists' helpers and molders' and coremakers' helpers. In roundhouse work, approximately 200 are employed wiping engines, with smaller numbers employed cleaning headlights and lanterns, supplying engines and operating turntables. More women are employed in car work than in any other branch of the mechanical department, the majority being listed as clerks and laborers. In addition, there are about 100 upholsterers and seamtresses, 50 pattern makers' helpers and about 90 painters' helpers, the remainder being listed as pattern makers' helpers, coach and car carpenters' and repairers' helpers and car inspectors' helpers.

A Welded Locomotive Tender Tank

BY J. W. MURPHY
General Foreman, Boston & Albany, West Springfield, Mass.

About six months ago, the Boston & Albany built at its West Springfield shops a tender tank of 8,000 gals. capacity, which was constructed entirely by welding the parts together by the electric arc process. So far as is known, this is the first departure from the customary riveted type construction for tender tanks.

Considerable experience had been gained with electric welding, particularly in boiler work, and in view of the successful results obtained and the adaptability of this process for welding seams of tanks, it was decided to construct a complete tank by electric arc welding. In the case of a riveted joint, considerable time is required for laying out and punching rivet holes and caulking. This work is not necessary in the case of electrically welded joints. Riveted joints cannot equal in strength the solid plate on account of the loss of metal at rivet holes, but welded joints if properly made have the strength of solid plate. It is recognized that the welded joint is strong and reliable and in the case of tank work there is the added advantage of freedom from leakage.

The electric welding process is superior to the oxy-acetylene process for certain kinds of work and is peculiarly adaptable for joining plates and welding seams. Oxy-acetylene welding can be used successfully in many kinds of repair work, but it is difficult to weld steel plates or sheets by this process on account of buckling and bulging produced by the heat.

The manner in which the sheets were welded to the tank angles is shown by Fig. 1. This is a satisfactory method as the welding can be done readily at reasonable cost and the strength of the joint is in excess of that usually obtained by the riveted type of construction. The side plates are butt-welded and the tank braces and splash plates are afterwards securely welded to the side sheets. The whole construction results in a water-tight tank of good appearance and great strength.

Fig. 2—All Seams in This Tender Were Joined by Electric Welding

In assembling the various parts of the tank, approximately 1,200 linear feet of welding was done. The following tabulation shows the welding work in detail:

Butt-welded seams ¼ in. plate	95 ft.
8 Reinforcing tees, 3½ in. by 3½ in. by ⅜ in.	550 ft.
10 Tank angles, 2½ in. by 2½ in. by 5/16 in.	410 ft.
23 Side tees, 3½ in. by 3½ in. by ⅜ in.	120 ft.
Beading at coal side	25 ft.
Total linear feet of welding	1,200 ft.

The safety appliances and tank lugs are riveted to the sheet. The completed tank is 26 ft. long, 10 ft. wide and 5 ft. 2 in. high, having a capacity of 8,000 gals. of water and 12 tons of coal. It is supported on a cast steel underframe and is used with a Pacific type locomotive in passenger service. The photograph shows the appearance of the completed tank, the absence of rivet heads being particularly noticeable.

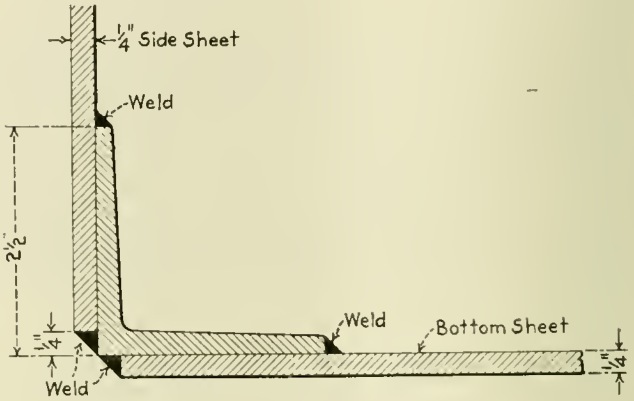


Fig. 1—Detail of Joint Between Angle and Sheets

The welded method of construction eliminates the necessity of punching rivet holes in sheets, tees and angles and there appears to be less likelihood of leaks developing in service. It is expected, therefore, that the cost of maintenance will be reduced. The welded tank has been in service for about six months and no defects of any kind have developed. Those who have had experience with the welded tender tank feel confident that this type will gradually supplant the customary riveted construction.

Cost of Operating Obsolete Machine Tools

Problems Arising in Its Determination: The Cost of Manufacturing Finished Railway Material

BY R. S. MENNIE

In any comparison between the machine tool equipment of an average railroad shop and that of a modern manufacturing plant, it will be quite evident that the latter is almost invariably provided with superior facilities. It will be found that antiquated machines are constantly used in railroad shops, which would not be tolerated in a successful manufacturing establishment.

To account for this fact we should remember that railroad shops are not engaged in the production of articles which must be sold at a profit. It is true that the railroad as a whole must operate at a profit or face ultimate disaster, but unfortunately this necessity has not the same direct bearing upon shop conditions that obtains in the industrial field.

Manufacturing companies usually have separate selling and shop organizations. Shop operations have a fundamental importance, exerting an immediate and vital effect upon the entire business. If these operations are conducted with waste or inefficiency, it is only under exceptional circumstances that the selling end of the organization can offset this loss by obtaining higher prices. Consequently, all factory matters having any effect upon the cost of manufacture are closely observed and by means of accurate accounting systems the management is able to locate inefficient conditions and apply corrective measures without expensive delay. We can therefore readily understand why obsolete machinery is quickly dispensed with under the urge of modern competitive production methods.

Cost Information Necessary

In a railroad shop, however, due to the absence of any real cost accounting system, it is impossible to show from day to day the exact cost of each unit of work done on these antiquated tools. If railroad shop officers had at their disposal accurate accounting methods similar to those used in the industrial field it would be a simple matter to compare the cost of certain items of work performed on obsolete machines and the same operations handled with modern facilities. Having unquestionable and reliable information very little further argument would be necessary to convince the management as to the advisability of installing new equipment.

It is of slight value, however, to enlarge upon what might be accomplished under certain ideal conditions unless one is prepared to show how these conditions can be brought about. It will no doubt require a considerable period to introduce and develop cost accounting systems for railroad shops to a state of practical perfection. In the meantime it may be of interest to discuss present possibilities and the problem before many shop officers of presenting facts to the management in a logical and convincing manner regarding the economic necessity for new machinery.

Requests for Machinery Without Facts Are Unsatisfactory

The usual procedure on the part of local shop officers is to obtain new machine tools by what might be called the "agitation method." Through persistent correspondence, conversation and other propaganda it is quite possible eventually to bring the management to the required state of mind, whereupon authority is granted for the necessary new facilities. The length of time that transpires in accomplishing this much desired result depends largely upon financial conditions and whether or not the higher officers have become somewhat immune and do not readily react to requests for purchases upon the basis of estimated savings which in the past have not always materialized. In fact, there is at times a decided inertia in regard to these expenditures.

However, as the cumulative effect of persistent small efforts is sufficient to overcome a comparatively great inertia, mechanical department men have gradually been able to replace some old machinery. The process is slow, at times discouraging, and the money lost by inefficient shop operations during the period of agitation is frequently sufficient to pay for the new tools with a considerable surplus in addition.

Matters of this kind are often a great puzzle to shop men and others not perhaps familiar with all phases of the situation. Consider the case of a machinist whose work consists in the daily operation of an old lathe that should have been scrapped 10 or 15 years ago. When he makes the necessary adjustments for a cut, perhaps one-half of what might be taken on a modern machine, and sets the feed to correspond, he knows beyond question that here is a waste involving many dollars. Consequently, his attitude toward any campaign for economy inaugurated by the management is at times tainted with a touch of sarcasm.

Nevertheless, while a mechanic or shop officer may be absolutely confident in his own mind that big savings could be made by installing new machinery, he is frequently at a loss when the time comes to demonstrate just what the anticipated savings would amount to in dollars and the exact manner in which his conclusions are arrived at. What the business man in charge of a railroad company's finances must have is a clear statement of facts, showing beyond question that the proposed investment will be profitable.

Preparation of Comparative Cost Statements

The preparation of such statements in the absence of a suitable cost accounting system can perhaps best be accomplished by making a careful analysis of operations performed on each machine. The number of units produced under normal working conditions should be ascertained, together with the cost of labor, power, belting and every possible item of expense. The initial investment should also be obtained and all capital charges included in the itemized statement of operating cost. The following examples will serve as a guide and may possibly be of some assistance to those not familiar with matters of this kind.

The first is a simple statement showing the annual operating cost of an obsolete 37-in. vertical boring mill, installed about 30 years ago at a total cost of $3,800, including foundation, countershaft, belting and all incidentals. The average production obtainable from this machine in the hands of a competent mechanic is three units a day, or 900 a year, with a power consumption of approximately 20,000 horsepower-hours.

With the above information at hand a statement may then be prepared somewhat as follows:

ESTIMATED OPERATING COST OF OLD 37-IN. BORING MILL

Interest on investment: $3,800 at 6 per cent	$228.00
Depreciation: $3,800 at 5 per cent	190.00
Maintenance: $3,800 at 4 per cent	152.00
Insurance and taxes: $3,800 at 3 per cent	114.00
Labor: 85c. per hour, 2,400 hours a year	2,040.00
Power: 19,200 horsepower-hours at 2c.	384.00
Oil, waste and grease	40.00
Total annual operating cost	$3,148.00

As this machine produces a total of 900 units a year the cost per unit will be $3,148.00 ÷ 900 = $3.50. In making these estimates it has been the writer's practice to determine the productive possibilities of a machine by ascertaining the number of units produced under average conditions in a given period. A unit may be a cylinder head, a piston head or any similar locomotive part. After running a short test to determine the rate of production, this rate may be used to arrive at the annual average output. Actually, however, in the course of a year the machine will be used on many different kinds of work, but for the purpose in view, this variety of output can be disregarded and the computation based upon a single unit of production.

In comparison with the old 37-in. equipment we shall now consider a 1921 model, 42-in. vertical boring mill. This machine, due to its massive construction, careful design and numerous time-saving features, will produce at least three times as much work as can possibly be accomplished on the older mill. The cost of this tool is about double that of the 37-in. machine and the power consumed is also considerably greater. Nevertheless, it will be found if a careful study of operating cost is made that the replacement of an antiquated 37-in. boring mill with a modern 42-in. machine will return an excellent percentage on the investment, providing of course that sufficient work is available to keep the new machine fully occupied.

Estimated Operating Cost of Proposed 42-in. Vertical Boring Mill to be Installed at an Investment of $7,500

Interest on investment: $7,500 at 6 per cent	$450.00
Depreciation: $7,500 at 5 per cent	375.00
Maintenance: $7,500 at 4 per cent	300.00
Insurance and taxes: $7,500 at 3 per cent	225.00
Labor: 85c. an hour, 2,400 hours a year	2,040.00
Power: 36,000 horsepower-hours at 2c	720.00
Oil, waste and grease	50.00
Total annual operating cost	$4,160.00

In the hands of an average machinist and under ordinary working conditions, it is demonstrable that a yearly production of 2,700 units can be obtained from the proposed new equipment, as compared with 900 units now secured from the present machine. The cost per piece will therefore be reduced from $3.50 to $1.54. The total expense to manufacture 2,700 units with existing facilities would be $3.50 × 2,700 = $9,450, as against $4,160; consequently the proposed new 42-in. mill would effect a net saving of $5,290 a year. This saving is a return of 70 per cent on an investment of $7,500.00.

Before statements of this character are presented to the management, care should be taken to verify all figures and in such a case as that just set forth, it is of vital importance to prove beyond question that the proposed new machine has an actual productive capacity of 2,700 units a year and that this figure is not a mere assumption. It may be possible that a machine of the proposed type is in service at some point on your railroad or perhaps in the shop of a neighboring road. In either event its average capacity can be readily determined. Machine tool manufacturers are always glad to indicate where their equipment may be observed in service and to be of any possible assistance in demonstrating its economic advantages.

When Expenditure Is Not Warranted

A mistake is frequently made in assuming that it is always a profitable investment to replace old machine tools with new equipment. When a careful analysis of the proposition is made it may be found that owing to abnormal conditions in the machinery market the cost of new tools is excessive. The investment is thereby increased so as to make capital charges, such as interest, depreciation, maintenance, etc., high enough to more than absorb all profit secured by increased production. This condition has been quite common during the past few years and will be more clearly understood by a study of the comparative cost to operate an old 84-in. driving wheel lathe installed at a total cost of $7,200 and a modern 90-in. machine representing an investment of $34,000.

Estimated Operating Cost of Old 84-In. Driving Wheel Lathe

Interest on investment: $7,200 at 6 per cent	$432
Depreciation: $7,200 at 5 per cent	360
Maintenance: $7,200 at 4 per cent	288
Insurance and taxes: $7,200 at 3 per cent	216
Labor: machinist and helper at $1.27 an hour, 2.400 hours	3,048
Power: 45,000 horsepower-hours at 2 cents	900
Oil, waste and grease	80
Total operating cost	$5,324

We will assume that the old 84-in. lathe has a capacity of four pairs of drivers a day. This is equivalent to a total production of 1,200 units a year. As the annual operating expense is estimated at $5,324, it follows that the cost to turn a pair of drivers on this machine is approximately $4.44.

A modern 90-in. driving wheel lathe installed at an expense of about $34,000 has a capacity of about seven pairs of drivers a day, under average working conditions. The operating cost may be estimated as follows:

Estimated Operating Cost of 90-In. Driving Wheel Lathe

Interest on investment: $34,000 at 6 per cent	$2,040
Depreciation: $34,000 at 5 per cent	1,700
Maintenance: $34,000 at 4 per cent	1,360
Insurance and taxes: $34,000 at 3 per cent	1,020
Labor: machinist and helper at $1.27 an hour, 2.400 hours	3,048
Power: 72,000 horsepower-hours at 2 cents	1,440
Oil, waste and grease	120
Total operating cost	$10.728

On the basis of an output of seven pairs of drivers a day, corresponding to a production of 2,100 units a year, the expense to turn a pair of drivers on this machine will be approximately $5.11. Inasmuch as the present cost is only $4.44 it is not possible to show that the proposed installation of a new 90-in. machine would be a profitable investment; at least not unless the investment can be considerably reduced.

Manufacturing Versus Purchasing

A frequent problem, arising in connection with the management of railroad shops, is that presented, usually by the purchasing department, when it asks whether it would be cheaper to manufacture or purchase a given article.

This question could of course be readily answered with the assistance of a suitable cost accounting system. In the absence of such a system the only accurate method of determining the total cost of manufacturing an article is to study carefully the time consumed in the various operations, the total investment represented by machinery and floor space, the percentage of supervision and other overhead expense properly chargeable to this account. If these items are given their correct value, together with the cost of whatever raw material is used, it will be possible to arrive at a reasonable approximation to the cost of manufacturing any article.

Certain complications frequently enter into these problems, particularly with respect to the proper capital charges to be made on the investment in machinery, buildings, etc., used for railroad manufacturing. Where these facilities are provided for this purpose only there can be no question as to the distribution of fixed charges. It is usual, however, to find that the machinery, buildings, etc., are normally a portion of the railroad's plant, primarily installed for the upkeep of locomotives and cars. The manufacturing proposition enters as an afterthought, due to the fact that there is not enough repair work to utilize the machine tool equipment up to its full capacity. Under these conditions, where capital charges have already been fully taken care of in the railroad company's books as an operating expense it would not be proper to enter them again as an item in any estimate of manufacturing cost.

Consequently, when otherwise idle machinery is utilized for local manufacture a railroad shop enjoys a considerable advantage, owing to the partial elimination of capital charges on this machinery. In many cases, however, this advantage is more than offset by the obsolete and inefficient condition of railroad shop machine tools and by the fact that these shops are not usually organized to compete with industrial establishments.

It will, therefore, be apparent that in the continued operation of antiquated machinery, railroad companies are penalized in various ways: viz.—heavy additional expense in machining repair parts, inability to compete with industrial concerns in the production of finished material, and the psychological effect upon shop mechanics compelled to witness a constant waste, leading to the inefficient performance of their daily tasks.

The "DeWitt Clinton" Moves Under Its Own Power

The locomotive DeWitt Clinton, and its three coaches, the historic New York Central passenger train, which for the past year has been on exhibition in the Grand Central Terminal, New York City, was taken to Chicago a short time ago to be exhibited at a pageant of progress exhibition held in that city.

For a short section of this journey the old locomotive was moved under its own power. For the rest of the trip the ancient train was carried on platform cars in a special train drawn by locomotive No. 999, which was one of the notable engines built for the New York Central by William Buchanan, 38 years ago, when the Empire State Express was first making its reputation. The illustration of this special train on this page is from a photograph taken at Erie, Pa. The 999 has been remodeled, since it was in service on the main line, and during recent years it has hauled passenger trains on the Pennsylvania division. For this special trip the tender was again painted and decorated in the style which was familiar to passengers at the time of the World's Fair in 1893.

The first trip made by the DeWitt Clinton with a passenger train was from Albany to Schenectady on August 9, 1831, so that the exhibition at Chicago marks the ninetieth anniversary of the life of the locomotive. In its present condition the locomotive weighs 9,420 lb. and the tender 5,340 lb. A standard New York Central Pacific type passenger locomotive, now in use, such as that shown in the illustration, weighs 276,000 lb., or about 11 times the weight of the entire train of 1831; though the gage of the track is the same now that it was then.

The DeWitt Clinton continued in active service for a period of 14 years. It hauled its trains at a maximum speed of 30 miles an hour on its first trip; but as fired up for the present exhibition it has been moved at only about eight miles an hour, no attempt being made other than to show that it was still in running condition.

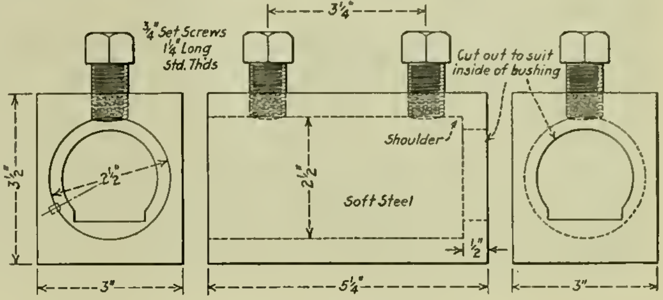
The "999" with the "DeWitt Clinton" at Erie, Pennsylvania

Jig for Machining Reversing Valve Bushing Seats

BY J. H. HAHN

Assistant Machine Shop Foreman, Norfolk & Western.
Portsmouth, Ohio

The illustration shows a jig to be used on the shaper for refinishing the seats of reversing valve bushings in 8½ in. cross compound air compressors. These seats wear rapidly in service and by removing the bushings from the top heads and placing them in the jig shown, the seats can be trued up very quickly. Extra large reversing valves which are now being furnished by the Westinghouse Air Brake Company can be fitted to these bushings, the whole operation being done in a few minutes. Large numbers of reversing valve bushings can be repaired or reclaimed by this method. The design and use of the jig is plainly shown. The jig is first chucked in the vise on the shaper table and the bushing inserted, the two set screws being tightened down just hard enough to hold the bushing and a special tool used to machine the seats. The jig is provided with a dowel pin to fit the key-way in the bushing which corresponds with the dowel pin in the top head of the air pump, thus holding the bushing in a central position and preventing any liability of its turning while it is being machined.



Jig for Holding Reversing Valve Bushings of 8½-In. Cross Com-

In making the jig a good deal of work can be eliminated by merely cutting off one end of an old reversing valve bushing and placing it in the end of the jig, securing it with screws or rivets. This will make it unnecessary to machine the end of the bushing to conform to the shape of the seat in the reversing valve bushing. Of course, this guide or shoulder in the end will have to be low enough to clear the tool when machining thinest seats which occur in worn bushings.

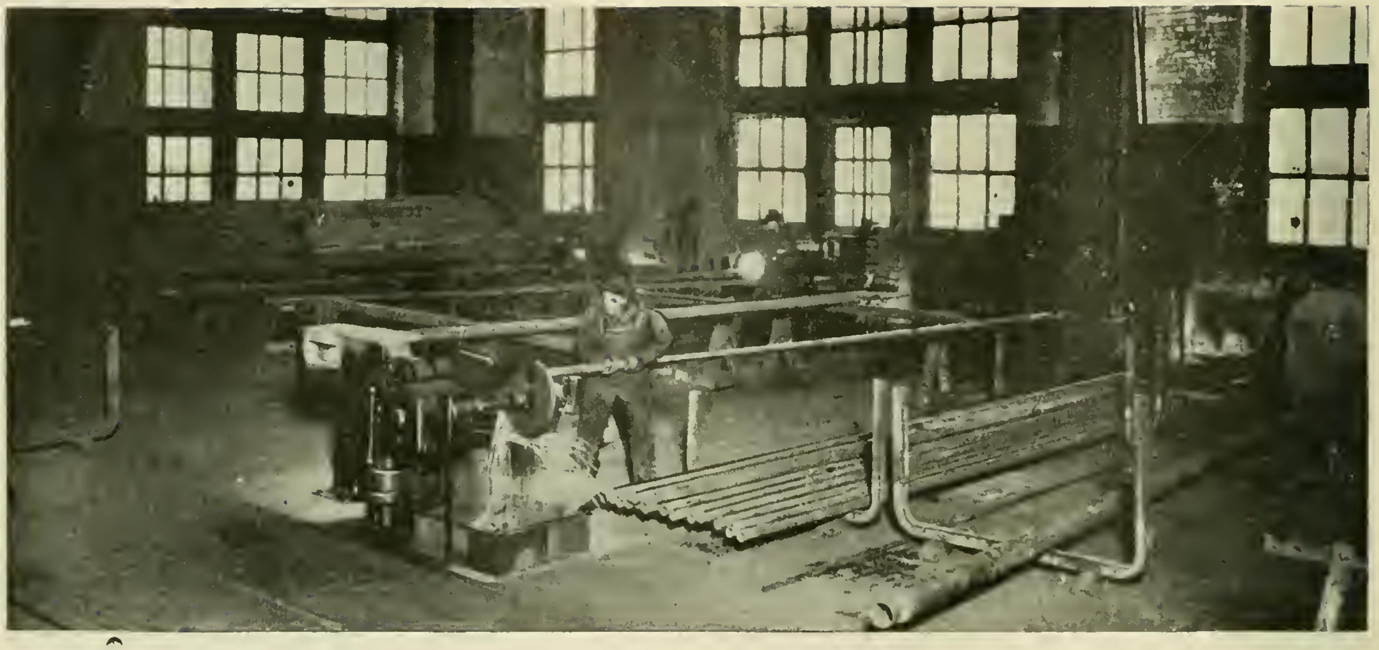


Fig. 1—General View of Delaware, Lackawanna and Western Flue Shop at Scranton, Pa.

Modern Equipment Facilitates Flue Shop Work*

A Description of Machinery and Methods Effective in Speeding Up the Safe Ending of Boiler Tubes

WITH a normal output of about 800 to 900 safe ended standard size tubes in an eight-hour day, the flue department of the Delaware, Lackawanna and Western shops at Scranton, Pa., has a production record that has justified the far sighted policy of the management in scrapping obsolete shop equipment and installing the most modern tools available. When the road was returned to the control of the company in 1920 after its release by the government it was decided that economies in the flue shop could be effected by the installation of an entirely new set of equipment. To this end engineers of Joseph T. Ryerson & Son, Chicago, with the co-operation of the railroad engineering staff, developed a flue shop layout that has greatly increased the operating efficiency.

> Methods of reclaiming and safe ending standard locomotive tubes and superheater flues employed in the Scranton shops of the Delaware, Lackawanna and Western represent the latest developments in this important phase of locomotive maintenance work. All machinery in the flue shop is of the most advanced design and is so arranged that flues follow from one stage to another with a minimum of handling and with a staff of only four men to operate the equipment.

Location of Shop

The flue department occupies a space about 110 ft. by 60 ft. in the south end of the west bay of the boiler shop, which is made up of four departments. The west bay contains an erecting shop and the flue shop; the two center bays are occupied by light and heavy machine tool equipment, storerooms, plate shops and the like, while in the east bay is located a second erecting shop. Part of the space in the flue shop, used for tube storage, can be adjusted to suit the requirements at any particular time, depending on the number of locomotives in the shop.

The buildings are of brick and steel construction with glass walls, making it possible for men to work under the most favorable natural lighting conditions. The shops are piped with air, water, oxygen and water gas for operating tools and heating furnaces. The east and west bays in which the erecting shops are located are each served by two Shaw electric cranes, one of 150 tons capacity and the other of 20 tons.

When an engine comes into the shop for repairs, it is dismantled and the tubes and superheater flues are cut out in either one or other of the erecting shops. The operation of cutting out the small tubes and superheater flues is done by means of air driven expanding cutters. The back ends of the tubes are cut out with an air hammer and the tubes passed out through the front tube sheet. They are then piled in racks until the entire set has been removed from the engine. In the west erecting shop, rope slings are passed around a bundle of tubes, which is then picked up directly by one of the cranes and taken to the flue department. In the east erecting shop the tubes are piled on trucks and transferred across the shop to the flue department, where the crane picks them up and deposits them in storage racks until they are put through the reconditioning processes.

Operations Carried Out in the Flue Department

Four major operations are carried out on tubes in the flue shop. They are cleaned, safe ended, short tubes are reclaimed and superheater flues safe ended. The machines are laid out

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*From an article in the August issue of The Boiler Maker.

as in Fig. 2, to carry out each of these operations, or combinations of several of them, without interference and with the least possible handling.

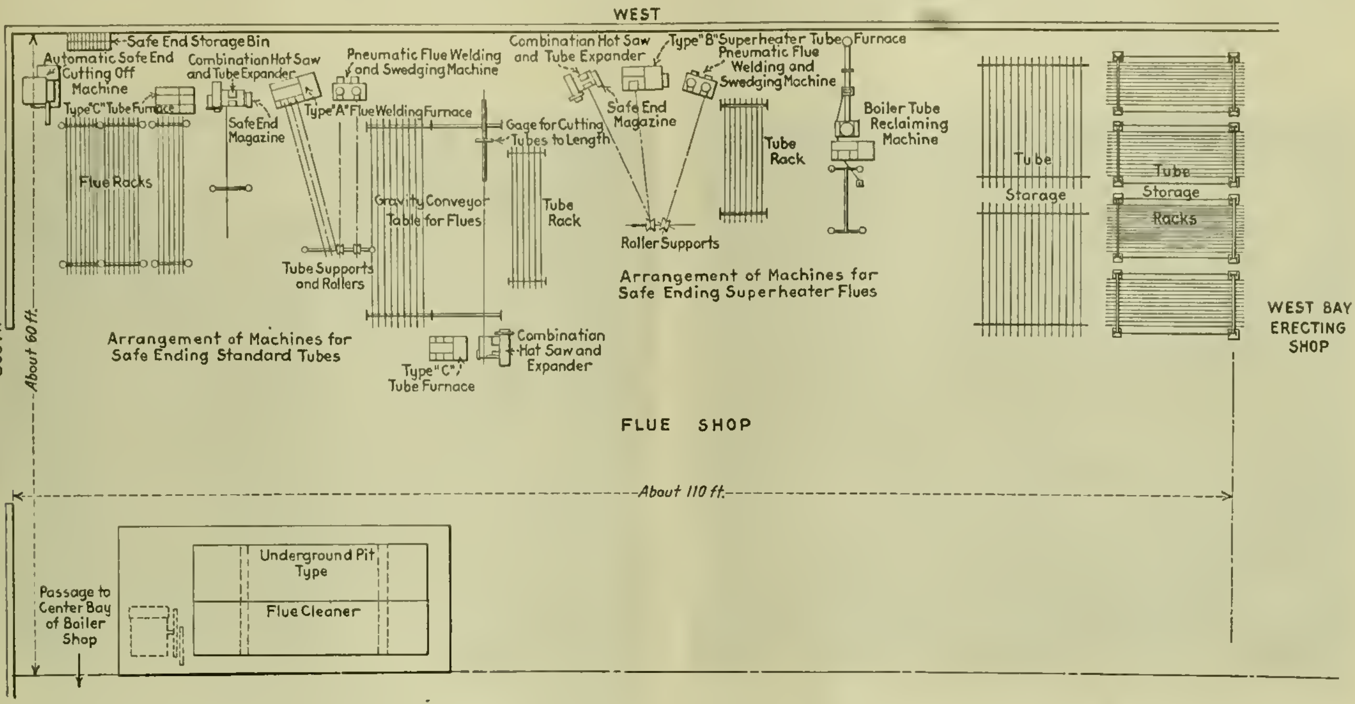


Fig. 2—Arrangement of Machinery and Equipment for Safe Ending Locomotive Boiler Tubes and Superheater Flues

The cleaning operation, which is the first process through which all tubes pass when brought to the department, is carried out in a Ryerson underground pit type cleaner, Fig. 3, which has a capacity of 350 2-in. flues up to 24 ft. in length at one time. In charging the cleaner, an entire set of flues is slung in chains and lowered by one of the shop cranes onto the rolling chains in the pit. The ends of the sling chains are fastened to hooks in the sides of the pit and remain hanging free from interference with the tubes in this position until after the operation is completed. Five sets of silent roller chains are fitted in the tank of the cleaner. Power is transmitted to the drive shaft through a silent chain by a 25-hp. motor. When the tubes are in place the tank is partly filled with water and the motor started. While the chains are in motion, the tubes are drawn through the water and partly up one side of the tank, where a draining action takes place and the tubes are tumbled back into the water and the process repeated, thus keeping them in constant agitation until absolutely clean. From two to six hours are required to clean tubes, depending on the hardness and thickness of the scale and on the water district in which they had been operating. One feature of the cleaner is that even while it is in operation the noise is practically eliminated and because the covers are flush with the floor the movement of materials in the section occupied by the cleaner is in no way held up. This is a big improvement over the common barrel type cleaner as the latter is usually located outside the shop. Such a location prevents handling all the tubes together by crane and keeps two men constantly busy loading and unloading the barrel cleaner.

After the tubes are cleaned the ends of the sling chains are picked up by the crane and the bundle of tubes removed to the racks near the first heating furnace. There is no direct

Fig. 3—Underground Type Tube Cleaner with Covers Raised

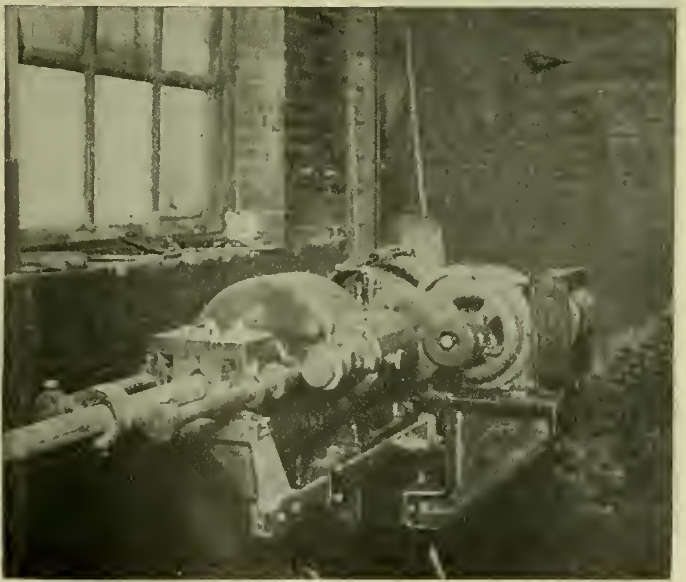


Fig. 4—Automatic Safe End Cutting Off Machine

labor charge in the cleaning of flues in the D. L. and W. shops, for the entire work of loading and unloading the cleaner is completed by the shop crane, usually under the direction of the fourth man of the repair unit. Not more than ten minutes' crane time is required for handling the tubes in this department. The cleaner will also turn out a set of forty-five 5⅜-in. superheater flues in the same time required for standard tubes; that is, from two to six hours.

The remaining machinery on the floor also is of Ryerson make, segregated in three sections with sufficient space between each unit so that the work may be carried on without interference. The standard 2-in. to 2¼-in. tube safe ending layout has for equipment two type "C" special tube furnaces, two combination hot saw and tube expanding machines (one with a safe end magazine), one type "A" flue welding furnace and one flue welding machine, occupying a section along the west side of the department about 40 ft. by 30 ft. In connection with the safe ending work an automatic safe end cutting-off machine is located in one corner of the shop.

Fig. 5—After Heating, the Fag Ends of Tubes Are Cut Off, Expanded and Safe Ends Inserted on This Machine

Fig. 6—Tubes Are Heated to the Welding Point, and Then Welded and Swedged on This Double Pneumatic Hammer

In the section devoted to the safe ending of superheater flues are one type "B" flue welding furnace; one combination hot saw and tube expanding machine with a superheater safe end magazine and one pneumatic flue welding machine and swedger.

Between the superheater section and the storage racks at the end of the department is a boiler tube reclaiming machine, used in reclaiming tubes not possible to handle in the standard 2 to 2¼-in. repair equipment.

Preparing Safe Ends for Welding to Tubes

The first step in the actual safe ending of the tubes is the cutting of stock tubing into safe ends of suitable lengths. The cutting machine for doing this work is automatic in operation and requires attention only when tubes are started in the feeding mechanism. Standard tubes from 1½ in. to

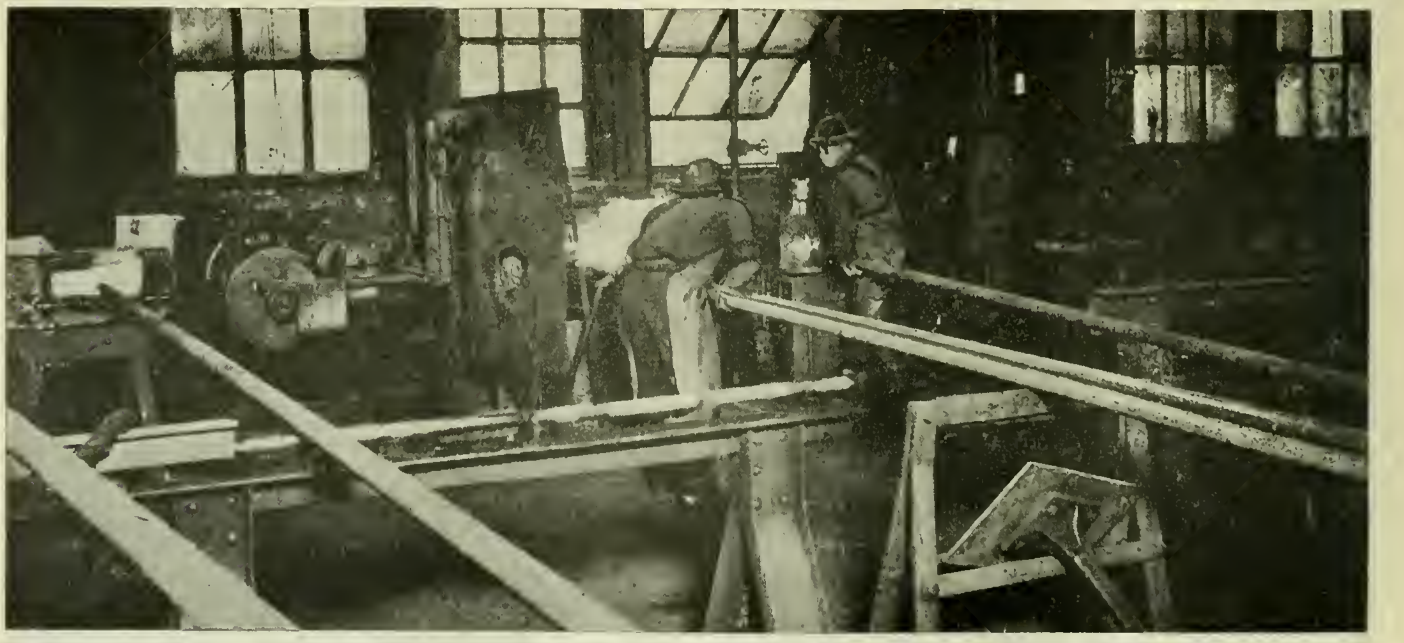


Fig. 7—The Entire Safe Ending of Boiler Tubes Is Carried Out on the Equipment Here Shown To Cut the Tubes to Length an Additional Heating Furnace and Combination Hot Saw and Expanding Machine Are Used

3 in. up to about 25 ft. in length can be fed into the machine. In general, the machine consists of a cabinet base on which is mounted an automatic, pneumatic chuck for gripping the tube; a cam feed cutting-off tool for cutting the tube to the proper length of safe end and, at the same time, scarfing the tube; a feeding device for moving the tube through the hollow spindle and a cutting compound circulating system. The operation consists of placing the tube in the hollow spindle, and when the machine is started, the air valve is opened by a cam and the chuck automatically grips the tube and rotates it with the spindle; the cutting tool meanwhile feeds up and cuts off the tube. The feeding chuck at the rear of the spindle then grips the tube and feeds it forward for the next cutting operation.

Fig. 8—Machines for Safe Ending Superheater Flues Are Located So That the Operator Has to Move the Tube Only a Slight Distance to Complete All the Operations

Safe ends ready for use are stored in racks adjacent to the cutting-off machine.

Process of Safe Ending Standard Tubes

When a set of tubes is ready for safe ending, after going through the cleaner, the shop crane places the bundle on a storage table near the heating furnace. The speeds of all operations on the tube preparatory to welding on the safe end are adjusted to the time taken up by the actual welding and all operations required after this are regulated by the speed of the welder. Tubes are fed by gravity down the storage table to a position near the furnace and the operator at this point, who controls the heating, places the fag ends of six tubes in the fire where they are heated to a cherry red. This furnace, a Ryerson type "C," is especially designed for use in conjunction with the hot saw and expanding machine. Although this type of furnace is generally equipped with oil burners adjusted for an oil pressure of 45 lb., in the D., L. & W. shops water gas is used for heating all furnace equipment throughout the entire plant. The capacity of the type "C" furnace is six 2-in. tubes or three 4-in. tubes at one time.

From the furnace, the tubes are pushed against the hot saw by the operator and the fag ends cut off. At the end of the shaft on the hot saw, a reamer is attached which is used to burr out the inside of the tube end and chamfer the outside edges. This same attachment is applied to all hot saw machines in the shop.

While the tube is still at a red heat the same operator places it in the expanding machine, Fig. 5, then removes it when expanded and inserts the tube, still hot, over a safe end which is dropped into place from the magazine. The three operations on the combination hot saw and expanding machine can be accomplished in about 12 seconds. The machine consists of a substantial base on which is mounted a small high speed saw, a pneumatic clamp and expander which operate independently, and a magazine in which the safe ends are fitted. Fag ends from the sawing operation drop into a small chute which is provided and are carried to a waste pan. The clamp for holding the tube in place for expanding has a lower stationary fluted jaw and an upper jaw mounted on a lever, connected with a pneumatic cylinder. Back of the tube clamp is placed a horizontal cylinder with a piston rod having a taper mandrel extending toward the center of the jaws of the clamp. In carrying out the operation, a control lever on the right of the clamp is thrown into action and the valve controlling the cylinder is opened, forcing the upper jaw down and clamping the tube in place. As the throttle lever is drawn towards the operator, the valve controlling the horizontal cylinder is opened and the expanding mandrel forced into the end of the heated tube. When the lever is thrown back, the plunger recedes and at the same time a safe end is dropped into place from the magazine; simultaneously the clamping jaw opens and releases the tube which is then shoved over the safe end and is ready to go into the furnace for welding. The machine operates at an air pressure of about 80 to 100 lb. and only about 3 hp. is required for the driving motor. The standard tube machine will accommodate tubes from 1½ in. to 3 in. in diameter.

Welding the Safe End

From the time the safe ended tube is put into the welding furnace, the second operator has charge of it. The type "A" furnace has three openings and will heat three 2 or 2¼-in. tubes simultaneously. Instead of oil burning equipment with which the furnace is generally equipped, gas burners have been fitted. When the proper welding heat has been reached, the operator places the safe ended tube over the mandrel in the pneumatic flue welding machine, Fig. 6, rotating it under the hammer until the joint is properly made. While still hot, the tube is moved to the right-hand cylinder of the machine for swedging. The double cylinder machine used consists of a heavy iron cabinet base on which is mounted the hammer mechanism. Separate foot levers control the welding and swedging hammers so that while the welding is being done,

Fig. 9—As in the Case of Small Tubes the Superheater Flues Are Welded and Swedged on a Double Pneumatic Hammer Which Operates at 80 to 100 Lb. Pressure.

the cylinder and dies used for swedging are idle, thus keeping the air consumption low. Different size dies permit tubes from 2 in. to 4½ in. in diameter to be welded. Mandrels can also be fitted to the machine so that it is possible to weld safe ends from about 3 in. to 12 in. in length. Tube dies are attached to the lower end of the piston with a key and travel in the guides of the upper frame. The operation of the piston is similar to that of an air hammer. The lower dies are held in a steel frame and all dies are so designed that they fit the outside of the flue with the proper allowance for expansion when heated. A scale scraper is fitted on the right-hand side of the frame near the lower die.

Cutting the Tube to Length

The final operation in reconditioning the tube is the cutting off of the smokebox end of the tube. The tubes roll along gravity racks from the welding machine to the third operator who places the ends in a second type "C" furnace where they are heated. As in the case of the first cutting off heating furnace, this furnace has a capacity to hold six tubes at once. When heated to a cherry red, the operator allows them to roll onto a rack having a gage at one end adjusted to the length required of the finished tube. He then places the heated end against the hot saw and after cutting off moves it to the expander. The tube is finally placed in a rack ready for installation in a locomotive in the erecting shop. Throughout the entire process the tubes are never turned nor reversed in direction. It may be said that the tubes are practically in motion from the time they leave the first rack until they are repaired and again ready for installation in an engine.

Machinery for Safe Ending Superheater Flues

The section of the shop devoted to welding safe ends on superheater flues is arranged in a slightly different manner from the small tube department as will be seen from the floor plan shown in Fig. 2. When a set of tubes is brought to the department and placed in the racks after cleaning, the operator places a single one of them in a type "B" welding furnace until it is heated to a cherry red. The three pieces of equipment in this department are arranged in an arc of a circle so that a tube supported at its outer end on a roller stand may be moved by the operator from the furnace to the hot saw, expander, and safe end magazine, and back to the furnace for the welding heat and finally to the welding and swedging machine by simply supporting the weight of the tube end on which the work is being done. The superheater flue welding furnace burns gas for fuel and will take tubes up to 6 in. in diameter. The combination hot saw and tube expanding machine is similar to that used in the layout for standard size tubes except that its capacity is for flues up to 6 in. in diameter. A five hp. motor is required to operate this machine. In the case of the pneumatic welding machine the capacity is for tubes from 2 in. to 6½ in.

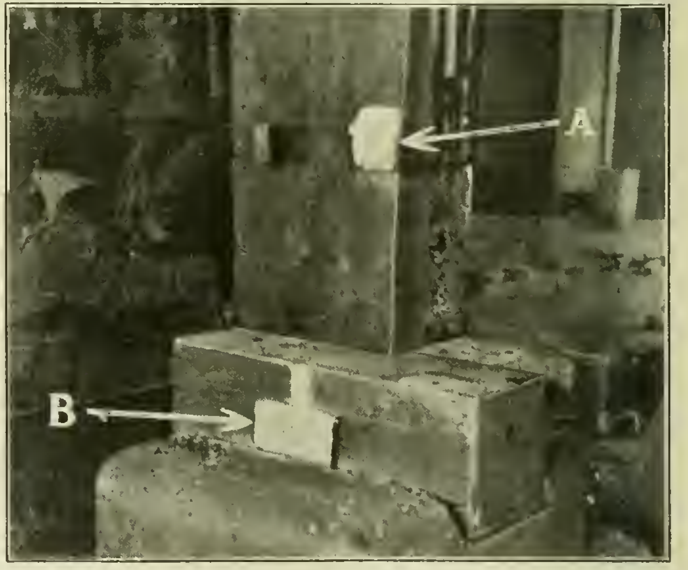
Reclaiming Short Length Flues

The practice of the D., L. & W. is to apply not more than two safe ends on tubes or flues. When tubes removed from a boiler have been pieced twice, they are either cut down and used on smaller engines or have a single long tube welded on the end in the flue reclaiming machine. Flues to be reclaimed are scarfed, expanded and placed in racks adjacent to the reclaiming machine. This equipment consists of a special pneumatic welding machine of the hammer type, an oil heating furnace and a special mandrel on which the tube is placed as shown in the arrangement plan of the shop. In this operation the tube is heated in the usual way, and the short tube used to piece out the length inserted. The tube and end are then passed through the furnace and over the mandrel until the point of weld is in the proper place for heating. When the required heat is reached the tube is moved forward through the furnace to the welding dies, the hammer being in direct line with the furnace opening. A stop is arranged on the mandrel which acts as a gage to locate the welding point. When the farther end of the tube strikes this stop it operates a lever which in turn actuates the air valve of the welding machine thus automatically beginning the welding operation. As soon as the pressure of the tube is taken from the gage stop, the air supply is cut off and the welding machine comes to a standstill. The tube is then pulled back through the furnace completing the operation. Finished tubes from each department are arranged in sets containing the proper number for installation in a locomotive and picked up by the shop crane and piled in storage racks.

Steam Hammer Repair

BY W. E. GIBBS

The illustration shows two thermit welds made on a steam hammer bottom die and head, enabling a 3,200-lb. hammer to be returned to service quickly at a minimum of expense. The steam hammer developed a bad crack where the upper die is keyed to the head, as shown at *A*. The head was removed from the hammer, the crack being burned out with the oxy-acetylene cutting torch and the surfaces chipped and cleaned for welding. The head of this hammer is 9¼ in. thick, 18⅝ in. wide and 51 in. long and on account of the severe service to which it is subjected, special care was taken in making the weld. After the weld was made, the head was machined and placed back in service, the hammer being ready for operation in a few days. One hundred pounds of thermit was used in making the weld, which required about ten hours' work. As the weld was made some time ago, it was necessary to have it chalked in order to show up.



Cracked Head and Bottom Die as Repaired by Thermit Welding

The bottom die head on this steam hammer broke squarely in two pieces at *B*. The die was placed on the surface table and lined up in the proper position, a 1¼ in. nut being placed in the center of the die between the two sections to allow proper space for the thermit steel. A strong clamp was placed around the outside of the flask. The thermit weld was poured and on cooling off, the reinforcement on the upper portion of the die was machined off to make the upper and lower dies square with each other. One hundred and fifty pounds of thermit were used in making this weld, which has given satisfactory service for eight months. The die is 10 in. wide by 11 in. thick and 30 in. long.

This steam hammer is subjected to unusually heavy duty and is in constant use forging open hearth steel up to 6 in. by 20 in. in cross section.

Labor Board Settles Overtime Controversy

Seven New Rules to Govern Punitive Payments; Hearings on the Re-establishment of Piece Work

SEVEN new rules, recognizing and continuing the principle of punitive pay for overtime work in railroad shops, have been promulgated by the Railroad Labor Board as the solution of one of the stumbling blocks in the negotiation of new agreements regarding rules and working conditions between many railroads and their shop employees. These new rules, which are effective as of August 16 and are retroactive to July 1, also recognize and sanction the principle of the eight-hour day, the policy of paying time and one-half for work performed on Sundays and holidays except that work which is absolutely essential to continuous operation and the practice of paying an allowance to an employee called but not required to work. On the other hand, the provisions of the seven new rules so change the overtime rules in the Shop Crafts Agreement that several of the wasteful and ridiculous effects brought to the attention of the Board during the hearings on national agreements will not be continued.

The new rules are to take the place of Rules 7, 9, 10, 12, 14 and 15 of the Shop Crafts National Agreement. The changes which have been made are briefly outlined in the following paragraphs. In all other respects the rules have been unchanged.

RULE 6

Instead of paying all shop employees time and one-half for Sunday and holiday work as was necessary under Rule 6 of the Shop Crafts Agreement, the new rule prepared by the Board provides that "employees necessary to the operation of power houses, mill-wright gangs, heat treating plants, train yards, running repair and inspection forces, who are regularly assigned by bulletin to work Sundays and holidays, will be compensated on the same basis as on week days." The new rule also contains the interesting phrase, "Sunday and holiday work will be required only when absolutely essential to the continuous operation of the railroad."

RULE 7

Rule 7 of the Shop Crafts Agreement has been changed so that instead of receiving a guarantee of one hour's pay for 40 minutes or less continuous overtime service with the right to go to meals after one hour's work, the shop employee will be paid time and one-half on an actual minute basis with a minimum of one hour, and he can be held for two hours before going to meals. The time then taken for meals will not terminate the employee's continuous service and must be paid for up to 30 minutes.

Again, instead of receiving five hours' pay for three hours and 20 minutes service or less when called to return to work the employee is to be paid a minimum of four hours for two hours and 40 minutes or less work. This four hours' pay must also be paid to employees called but not used.

During the course of hearings on the national agreements the railroads objected particularly to the provision of the old rule which allowed the employee to collect 10 or 15 hours' pay on the ground that, when he had completed the task for which he was called, his assignment to other emergency work constituted a second and sometimes a third call. To offset this the new rule says: "Employees called * * * will be required to do only such work as called for *or other emergency work which may have developed after they were called and cannot be performed by the regular force in time to avoid delays to train movement.*"

The new rule also makes provision for paying employees time and one-half on an actual minute basis with a minimum of one hour for work performed in advance of the regular working period.

RULE 9

Rule 9 in the Shop Crafts Agreement gives the employee who works through his lunch period one hour's pay and the opportunity to procure his lunch later without loss of time. The new rule gives him but straight time and the opportunity to procure his lunch later without loss of time *up to 30 minutes.*

RULE 10

The railroads protested the provisions of Rule 10 of the Shop Crafts Agreement which enabled shop employees, sent out on the road for emergency service, to receive, under certain conditions, time and one-half for time spent in waiting for trains or in traveling. The new rule prepared by the Board eliminates these provisions, giving the employee on such work straight time for all time waiting or traveling.

The time of the employee sent out for such service was formerly reckoned from the time called until his return, but under the new rule his time begins when he leaves his home station.

Again, when such emergency service kept the employee on the road for several days, including either Sundays or holidays, he was guaranteed eight hours pay for week days and time and one-half for Sundays and holidays. Under the provisions of the new rule he is guaranteed but eight hours pay for each calendar day.

The new rule also provides that when an employee is required to leave his home station during overtime hours he will be allowed one hour's pay as preparatory time.

The following provision for wrecking service employees is added to the new rule:

"Wrecking service employees will be paid under this rule, except that all time working, waiting or traveling on Sundays and holidays will be paid for at rate of time and one-half, and all time working, waiting or traveling on week days after the recognized straight-time hours at home station, will also be paid for at rate of time and one-half."

RULE 12

Changes similar to those made in Rule 10 are made in Rule 12, the provisions of which apply to employees sent out to fill temporary vacancies at outlying points. The railroads particularly objected to the last paragraph of Rule 12 of the Shop Crafts Agreement, which continued those rules more favorable to the employees in older agreements. The new rule contains no provision for the continuation of these older rules.

RULE 14

Those shop employees regularly assigned to road work who have been paid, under Rule 14 of the Shop Crafts Agreement, straight-time for their regular hours and time and one-half for all overtime hours whether working, waiting or traveling will, under the revised rule, receive straight time for all hours traveling, waiting or working during regular hours and time and one-half only for work performed during overtime hours.

The new rule also contains the following paragraphs which are not included in the old rule.

"Where meals and lodging are not provided by the company when away from home station, actual expenses will be allowed.

"Where employees are required to use boarding cars, the railroad will furnish sanitary cars and equip them for cooking, heating and lodging; the present practice of furnishing cooks and equipment, and maintaining and operating the cars, shall be continued."

The starting time in both the old and revised rules is set at from 6 a. m. to 8 a. m. However, the following exception is included in the new rule:

"In case where the schedule of trains interferes with the starting time an agreement may be entered into by the superintendent of the department affected and the general chairman of the craft affected."

Rule 15

Rule 15 of the Shop Crafts Agreement has been changed to conform to the Board's decision relative to the payment of time and one-half for work performed on Sundays and holidays inasmuch as this rule applies to employees regularly assigned to road work and paid on a monthly basis. Whereas formerly the monthly rate of these employees was determined by dividing 3,156 hours, which includes 59 Sundays and holidays at time and one-half, by 12, their monthly rate is now to be deducted by dividing 2,920 hours, or 365 eight-hour days, by 12.

The new rule also contains the following paragraphs which will eliminate some of the features to which the carriers have strenuously objected:

"The regularly assigned road men under the provisions of this rule may be used, when at home point, to perform shop work in connection with the work of their regular assignments.

"If it is found that this rule does not produce adequate compensation for certain of these positions by reason of the occupants thereof being required to work excessive hours, the salary for these positions may be taken up for adjustment."

Board Outlines Its Opinions on the Subject of Overtime

The Board in handing down these new rules said in part:

There was a wide diversity of rules among the numerous railroads of this country prior to the standardization that took place during federal control. It is therefore possible to cite precedents for almost any rule that may be advocated. Such precedents, at best, are persuasive, but not controlling. The fact that a given rule may once have existed by agreement on a road is not conclusive of its reasonableness and justness, for it may have been imposed on the employees by unavoidable necessity or on the carrier by economic pressure. The Board has therefore felt constrained to consider the principles of right and wrong involved in the proposals and counter-proposals submitted to it, in the light of present conditions and industrial history.

Throughout these rules, the soundness of the principle of punitive pay for overtime work has been recognized, but not to the extreme extent embodied in the National Agreement.

The eight-hour day has also been given full recognition. The policy of paying time and one-half for work performed on Sundays and holidays is also approved in Rule 6, but an important exception is provided. Certain kinds of work, which are unavoidably and regularly performed on Sundays and holidays and which are absolutely essential to the continuous operation of the railroad to meet the requirements of the public, are not treated as overtime work. The carrier has no choice as to the performance of this work, and does not arbitrarily require it. It is not just to penalize the carrier for that which it cannot escape. Manufacturing plants can, as a rule, control or eliminate Sunday and holiday work, therefore, a comparison of such plants with a railroad is unfair, except in so far as the "back shop" is concerned, and the method of paying for overtime in the back shop has not been disturbed by these rules.

There are other classes of employment in which Sunday and holiday work is regular and necessary, and those engaged in it are not paid overtime; for example, engineers, firemen, conductors, and trainmen, and, going outside of railroad service, police and fire department employees, and street car conductors and motormen.

The practice of allowing five hours for a call is a relic of the time when ten hours constituted a day's work, and it was thought just and reasonable to allow one-half day, or five hours, for a call. Now that the hours have been reduced to eight, by the same principle, it is just and reasonable to make the allowance one-half day or four hours.

Employees usually commence work between 7 a. m. and 7.30 a. m., with a lunch period in the neighborhood of 12 o'clock noon, and finish their regular eight-hour period at 4 p. m. Certainly, there is no hardship in asking employees to continue on to 6 p. m. (if their services are required) before they go to a meal, and in many cases workmen would prefer to work the additional two hours in order to complete their work and go home without having to return.

If men are called after regular hours for some emergency work, it is fair and reasonable to use these men only on other emergency work which may have developed after they were called without being obliged to call them again or to call other men.

When men are sent out on the road for emergency service, or to fill temporary vacancies, it is certainly just and reasonable to pay them straight time for all time traveling or waiting, and for all time worked, straight time for straight-time hours, and overtime for overtime-hours in accordance with the practice at the home station or at the point where they are temporarily employed.

It is just and reasonable that men assigned to road service on a monthly basis should be paid eight hours per day, 365 days per year, without any allowance for overtime.

It is a fact that on many Sundays and holidays these men are not called upon to work, but no deduction is made in their pay. These monthly positions must be desirable because they are usually occupied by the older men, and there is regularity as to the monthly compensation.

The Board has felt impelled, however, to decline many of the modifications of said rules advocated by the carriers, because they appeared to go to an opposite extreme that is unjust and unreasonable. In this case, as so often happens in human experience, there is a point somewhere between the extreme positions of opposing forces where justice and reason may be found.

The rules above set out will become effective August 16, 1921, except that employees who have been paid under a less favorable rate or condition for the period embracing July 1 to August 15, 1921, inclusive, shall be reimbursed under these rules.

Dissenting Opinion of A. O. Wharton

For the first time in the history of the Labor Board a dissenting opinion accompanied the decision. A. O. Wharton, labor representative on the Board, in a lengthy argument opposed the decision of the majority on the grounds that "it does not appear either just or reasonable that conditions that have been in effect from 10 to 20 years and even longer, established as a result of negotiation and mutual agreement between employers and employees, and not infrequently established where no organization of employees existed, can now be decided as unjust or unreasonable." In support of this contention Mr. Wharton cited the overtime provisions for the shop employees in effect on approximately 100 carriers prior to December 31, 1917, adding, "No charge was made by the carriers and no evidence submitted to the Board that would justify any statement to the effect that any of the rules resulting from negotiation between 1902 and December, 1917, were the result of an undue exercise of the economic strength of the employees' organizations."

Regarding the majority ruling as to straight time rates for Sunday and holiday work for certain classes of employees whose work is necessary to maintain continuous operation, Mr. Wharton said:

"As a matter of fact and recorded in the public hearings conducted by the Board, with representatives of the carriers present and not challenging the statement, overtime at the rate of time and one-half for Sunday and holiday work, and for work outside of the regular established day, has been in effect for this class of employees for not less than 40 years; it was voluntarily put into effect 20 years prior to the time the shop crafts had organization sufficient to negotiate working conditions."

After making several comparisons regarding practices of public utilities and municipalities regarding punitive payments for Sunday, holiday and overtime work, Mr. Wharton cited a compilation prepared by representatives of the Federated Shop Crafts and showing the overtime practices prevailing in 2,544 firms in practically all states of the union during 1920. This compilation shows that 869 of these firms paid double time for all overtime, that 2,270 paid time and one-half or better for all time worked outside of regular hours and that but 49 paid straight time for all overtime.

"The plea that continuous service requirements should be a controlling factor in deciding that employees should be compelled to perform Sunday and holiday service for the same rate paid on week days," Mr. Wharton continued, "or that men should be assigned to duty 365 days per year, with millions of workers walking the streets in search of employment is a fallacy not sustained by any recognized authority qualified to pass . . . upon a question . . . associated with the social and moral well-being of the nation's workers."

Hearings on Piece-Work

Hearings on the subject of piece-work were begun for the Labor Board on August 8 and concluded on August 12. In the course of the proceedings, vice-chairman Hooper stated that the only question before the board was whether or not the rule prohibiting piece-work should be continued.

A large portion of the first day's testimony was taken up with a plea by B. M. Jewell, president of the Railway Employees' Department of the American Federation of Labor for separate hearings on each disagreement certified to the board during the past few weeks. J. G. Walber representing the eastern carriers stated that the railroads intended to rest their case largely on the testimony presented by the Conference Committee of Managers during the hearings on the national agreements. On August 9, the board announced that four days would be allowed to the employees to reply to the piece-work testimony of the Conference Committee of Managers and one day would be devoted to rebuttal statements from representatives of the railroads.

Committeemen representing the shop employees of 28 eastern and 26 western carriers appeared before the board on August 10 and vigorously protested the re-establishment of piece-work. Practically all of the local committeemen stated that from 95 to 100 per cent of the shop employees represented by them voted against the re-establishment of piece-work on the ground that this system of pay works a hardship on the employees, constitutes a form of slavery, prevents the payment of punitive overtime and makes impossible the payment of a living wage. Many of the committeemen based their arguments largely on the fact that the re-establishment of piece-work would wipe out their punitive overtime to a great extent and the introduction of this argument was protested by Mr. Walber, who called attention to the fact that the present hearings were on the question of piece-work. Mr. Jewell replied that the two subjects are so closely allied they must be considered together.

The hearings on August 10 and 11 were devoted principally to the presentation of an exhibit by Leland Olds on behalf of the Railway Employees' Department of the American Federation of Labor. This exhibit, entitled "The Problem of Piece-Work," dealt at length upon the "fluctuation" in earnings of shop employees under the piece-work system of pay. The attempt was made to attribute this "fluctuation" to conditions other than the workers' willingness or ability to produce by reference to disparities in the amounts earned by the same workers during various periods. The exhibit was divided into three parts, the first part of which is devoted to refutation of the evidence presented during the hearings on national agreements by the Conference Committee of Managers; the second part to a description "of what piece-work is in railroad shops," and the third part to the "comparative economy possible under the two systems."

Samuel Higgins, railroad representative on the board, in questioning Mr. Olds, brought out the fact that although the latter had entire charge of the preparation of this exhibit he is not a graduate of a technical school nor had he had any experience in railroad shops. Mr. Olds stated that he had depended for his experience upon the experience of the railroad employees who had supplied the material and arguments contained in the volume.

J. G. Walber Opens Railroad's Case

On April 12 John G. Walber, representing the eastern carriers, opened the testimony on behalf of the railroads by telling the board in substance that if the final decision of the board in this controversy results in preventing the carriers from doing work in their own shops except at excessive costs they will be forced to give their repair work to outside plants. In discussing the charges made by the employees, Mr. Walber said in part:

> Of all the charges of abuses and improper conditions under the piece-work system of pay there is none which cannot be corrected, if justified. The frequent charge that it is possible for employees to do inferior work and even fail to do work cannot properly be considered an argument against the system, as such a charge cannot be confined to piece-work and is equally possible under any other system of pay. If employees will neglect their work when paid on the piece-work basis, they will do the same on the hourly system, as the controlling element is the character of the individual.
>
> Whether or not the piece-work system of pay yields proper compensation for the work performed depends primarily upon the prices set for the jobs. With the prices properly set, we are unable to see what sound objection can be made to the system, if employees are willing to render adequate and proper services. The hourly system of pay allows no consideration for the industrious employee. All are on a common basis. It is the ambition of most energetic men to profit by their work; many have the ambition to engage in business for themselves. The piece-work system gives the employee this advantage and the ambitious, energetic employee receives compensation in proportion to his contribution to the output.

After urging the re-establishment of piece-work and the revision of piece-work rates to conform with changed conditions, Mr. Walber said:

> In such revisions, prices should be fixed which shall not impose excessive application of the employees in order to perform the jobs within the time used in fixing the unit prices, but if controversies arise as to the results of the unit prices, and it is not possible to amicably adjust them between the managements and the representatives of the employees, they can be referred to the Labor Board in accordance with the provisions of the Transportation Act. That act has come into existence since the piece-work system of pay was discontinued, so that today the employees have a Board to which they can appeal in the event any complaints against improper results cannot be adjusted on the home roads.

The rebuttal by the railroads' representatives was largely devoted to pointing out contradictory statements and illogical reasoning in the exhibits presented by the unions. The testimony of Frank McManamy was criticized on the ground that he was not a disinterested witness.

J. W. Higgins, testifying in behalf of the western roads, offered as evidence in this case the testimony presented to the board by the Conference Committee of Managers during the course of hearings on national agreements. Mr. Higgins also asked for opportunity to reply to the material contained in the employees' exhibit on piece-work, and this request was granted. Dr. C. P. Neill, representing the southeastern roads, made a similar presentation.

The hearings were closed with a statement by B. M. Jewell on behalf of the employees in which he summed up the employees' objections to the re-establishment of piece-work.

Orders have been issued by the Bureau of Valuation of the Interstate Commerce Commission closing the five district offices and consolidating all work in Washington. H. M. Jones, member of the Engineering Board, with headquarters at Chattanooga, has been appointed supervising engineer and T. P. Artaud, supervisor of land appraisals at Washington, has been appointed executive assistant. It is expected that staff positions in district offices will be abolished as the offices are closed.

Fuel Conditions on the French Railways*

Use of Mixtures and Briquettes; Trend of Locomotive Development; Training of Crews

BY M. DE BOYSSON,
Chief of Locomotive Service, Paris-Orleans Railway, Paris, France

THE average price of French coal and imported coal was, in 1920, more than 250 francs ($50) per ton. The amount of ash, which in ordinary times averaged from 8 to 10 per cent, rose to an average of nearly 17 per cent. At the present time the French railways are paying about fifteen times the pre-war cost for fuel and the total fuel bill now amounts to about 35 or 40 per cent of the total operating expenses as compared to about 16 per cent before the war.

Unfortunately, in spite of the increase in price, it has not been possible to accomplish much in the direction of economy. The reason for this is due to the scarcity of coal, the difficulty of obtaining sufficient supplies of all kinds to provide the proper mixtures, and the fact that a large number of inexperienced men have had to be employed to replace the men lost in the war.

Choice of Fuel

The destruction of the mines in the North and the Pas de Calais districts, greatly reducing the coal resources of France, no longer permitted the railways to choose the fuel best suited for locomotive use and they have had to be satisfied with what they were able to obtain. The situation has, however, improved a little during the past few months and the railways are gradually returning to more economical methods.

The French mines from which the railways draw their supplies produce a fairly large proportion of small coal and, further, screened coal coming from abroad arrives with a large amount of coal dust caused by repeated handling. It is necessary to find a use for this small coal and dust, of which there is too large a quantity to be burned as it stands. Briquetting solves the problem and at the same time increases the supply of select coal, which is not obtained in sufficient quantities from the screened coal to meet the needs of the country. Briquettes are made by mixing 92 parts, by weight, of coal with 8 parts of resin. This mixture forms a briquette of good quality which can be used under the same conditions as the best coal, both under difficult operating conditions and for firing up. The total cost of this briquetted coal is practically the same as that of screened coal and the briquettes have the advantage in that they can be handled and stored in the open with much less deterioration than the screened coal. The weight of the briquettes varies from 6 to 20 lb.

It is the practice of the French railways to mix different grades of fuel in order to obtain the most economical combination for the locomotive service involved. These mixtures will contain more or less high grade fuel according as the service is more or less difficult.

Fuel Stocks and Methods of Handling Coal

In order to obtain the proper mixtures it is necessary to have at each coaling station a fairly large stock of fuel, because regular deliveries of the different grades of fuel cannot be depended on. A large stock is still more important in districts which are supplied with imported fuel. The normal stock allowed for the railways was about three to four weeks' supply for pit coal and six weeks' to two months' for briquettes. The latter should not be used until they are dry, which takes about a month after they are manufactured. The coal coming from the ports is either mixed immediately when it arrives at the coaling stations, or is placed in separate piles, if the arrivals are too irregular, and mixed in the desired proportions when it is loaded onto the locomotive.

In order to facilitate making these mixtures, mechanical methods of handling have been devised which have the added advantage of reducing the cost of handling.

The coal cars at the coaling stations are unloaded by steam or electric traveling cranes. At engine houses of medium size the locomotive tender is loaded with the same apparatus that is used for unloading the coal as it arrived from the source of supply. In the larger engine terminals, however, the two operations are distinct, principally because the lack of space required that the storage ground for the fuel be placed at a considerable distance from the engine houses. When the locomotive tender is not loaded directly by means of cranes, one of the following two methods is adopted: (a) the coal is placed in small push cars, holding about 3,000 lb., and pulled up an inclined trestle by an electric hoist, where the coal is dumped directly onto the locomotive; (b) the coal is raised, either by a crane or chain buckets, into a regular coal chute from which it is delivered directly to the locomotive.

Purchase and Inspection

On account of the various qualities and sources of supply of the coal used, it is not possible to rely upon the analyses at the mines. The contracts are therefore made for each different grade of coal, fixing the maximum amount of ash and also quantity of water in washed coal at the point at which the fuel is received. Fines or premiums are provided for coal whose maximum is above or below these figures. In the case of briquettes there is an additional cohesion test.

The ordering, inspection and handling of fuel is under the control of a special department, which may or may not be under the jurisdiction of the general supply department of the railways.

Locomotive Improvements for Economical Operation

The use of brick arches, while at the same time protecting the tube plate, has reduced the fuel consumption by 3 or 4 per cent. At the present time all the French locomotives are equipped with them.

The dumping grate and the shaking grate, while not reducing the fuel consumption, have allowed the use of inferior fuel. The dumping grate is used on all engines and the shaking grate on most of the modern engines.

The use of a circular exhaust nozzle, with a variable opening, gives the maximum draft with the least back pressure. Great progress has already been made in the study of the best arrangement for exhaust nozzles; new ones are still being tried.

Boiler lagging is not in general use as the cost of upkeep seems to equal the saving made on the fuel. However, new trials are being made taking into account the present price of coal.

Compounding has realized an economy of 10 per cent compared with the ordinary engines. At first compounding was applied to two-cylinder locomotives, but they have been almost entirely given up on account of the unequal balance

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*Abstract of a paper presented before the 1921 convention of International Railway Fuel Association.

caused by this arrangement. All the recent compound engines have four cylinders.

The use of the superheater overcomes the necessity of increasing the steam pressure as required for corresponding and gives, in the case of powerful engines, a saving of about 12 per cent on single expansion engines and 8 per cent on compound engines of the same type. In spite of the economic advantage of compound engines with a superheater and four cylinders, the tendency at present is to return, at any rate as regards engines of average power, to simple engines with a superheater and two cylinders on account of a considerable saving in maintenance and the increased facility of operation.

Feed water heaters using exhaust steam were tried before the war. More than one hundred engines are already fitted with this apparatus. These feed water heaters achieve a certain saving of fuel, but on the other hand there are maintenance difficulties and the question is deserving of thorough study.

Mention should also be made regarding the development of washing and filling boilers while they are hot. Instituted at first in order to diminish the stress of metal in the boilers and to allow the engines to be used again sooner, this process also allows, in certain cases, the recovery of the heat contained in the water of the boilers which are emptied. However, this recovery required extensive apparatus which it was out of the question to install during the war. The present prices are too high for the expected saving to compensate to a sufficient degree for the cost of the apparatus.

Mechanical stokers have not yet been applied to French locomotives. The limitation of the weight per axle (18 tons) does not allow of boilers powerful enough to make these stokers indispensable. Neither has any use been made of pulverized coal, but the railways are following with close attention what is being done abroad and the trials undertaken in France, in order to be able eventually to adopt the practice more or less extensively.

Training of the Engine Crew and Supervision

The hiring and training of locomotive engineers and firemen have always been closely watched by the railways. The employees start as workmen or laborers in the engine houses. After a theoretical and practical examination they can, after a certain time, be employed as extra firemen according to the requirements of the service; but they are not called firemen for a considerable time, which, before the war, was not less than three or four years. After acting for some time as firemen, depending on the aptitude of the employee, they have to undergo a more complete theoretical and practical examination to prove their fitness for the duties of locomotive engineer. Before the war a man was not made an engineer, except in special cases of those who had a more complete training, in less than seven or eight years, of which three years were served as fireman.

During the whole training period the employees are carefully supervised and placed under locomotive engineers who are particularly qualified to act as instructors. During their work the engineers and firemen are frequently accompanied by traveling engineers, who complete their instruction.

The necessity for increasing the strength of the staff very quickly on account of the requirements arising from the war and especially on account of the application of the eight-hour day, forced the railways to train the engine crews very hurriedly and to reduce the length of the term of probation, certainly to the detriment of the skill of the employees and the fuel consumption.

It is not enough to train the engine crews; they must also be interested in producing results. To accomplish this the railways give the engineers and firemen a share in the fuel savings. A certain quantity of coal is allotted to each service, based either on train-miles or ton-miles and the saving made on the allotment is paid to the men at a contract price. The results obtained from this premium were very satisfactory. Recently, owing to pressure from the unions, a guaranteed minimum of premium has had to be assured to the men each month, whatever the amount of the premium actually realized, and many of them have been content to draw this minimum without trying to obtain greater savings.

The maintenance of the locomotives is also closely watched. Strict rules as to the periodical inspection of the engines are in force at the engine houses and supplementary inspections must also be made whenever it is necessary to maintain the engines in good condition. Provision is made in particular for the piston rings to be replaced about every 20,000 miles; but the rings are replaced before this when the wear exceeds a certain amount. The cylinders are rebored when the difference between two perpendicular diameters reaches 1.5 m.m. (.06 in.). A sharp lookout is kept in this respect at the main shops.

Assigned Locomotives

In general, each engine is assigned to an engineer who alone is to use it. This arrangement gives excellent results as regards economy in fuel consumption. Moreover, in this way more delicate and more economical machinery can be used, because it can be kept in better order. Naturally, this method requires a large number of engines. However, the difference is not so great as might be supposed at first sight, for the better care the engines receive greatly reduces the number of engines held out of service for incidental repairs. From the attempts made by the railways to pool the engines on account of the lack of engines during the war and at the time of the application of the eight-hour day, together with the observations made on the results obtained in the transport service by the American forces in France during the war, we have been able to draw the conclusion that, even in the case of two-cylinder single expansion engines the number of locomotives required for the assigned service, only slightly exceeds—less than 10 per cent—that required in the pooled service. With the more complicated compound engines, the maintenance of which requires more attention, the difference would be still less and, perhaps, even to the advantage of the assigned system.

As this latter system is much superior as regards fuel consumption and cost of maintenance, the French railways continue to use it even though the eight-hour day has increased the number of engine terminals and the number of engines themselves.

Conclusions

The efforts which the railways made to reduce fuel consumption had produced very considerable results before the war. In both passenger and freight service the fuel consumption per gross ton-mile hauled, had diminished by more than 10 per cent between the years 1900 and 1913, in spite of an appreciable increase in speeds. Unfortunately, the disorganization occasioned by the war has caused the greater part of the progress made to be lost.

Experiments have been made for replacing coal with liquid fuel and also by the development of electric traction. Several engines have been equipped to burn oil, using the oil burning arrangements adopted in the United States. Up till now the results appear satisfactory from an operating point of view, but France does not possess any oil and has to import it. The problems of the cost of this fuel and certainty of supplies are still far from being solved.

On the other hand, the development of electric traction with hydro-electric power stations—there is abundant water power available in France—is certain. The three railways which are in mountainous districts, the Paris-Lyon-Mediterranean, the Paris-Orleans, and the Midi, have drawn up programs including, from now onward, the electrification of a large portion of their lines. Surveys are being made, a large part of the concessions granted, and the work will commence shortly. Nevertheless, it will still be some years, especially with the present delays in construction, before an appreciable saving in coal is reached. It will be possible to make a saving of 3,000,000 tons of coal per year when the whole program is completed.

Even for parts where steam-driven electrical power stations have to be used, the substitution of electrical power for steam locomotives ought to bring about a saving in coal of about 50 per cent.

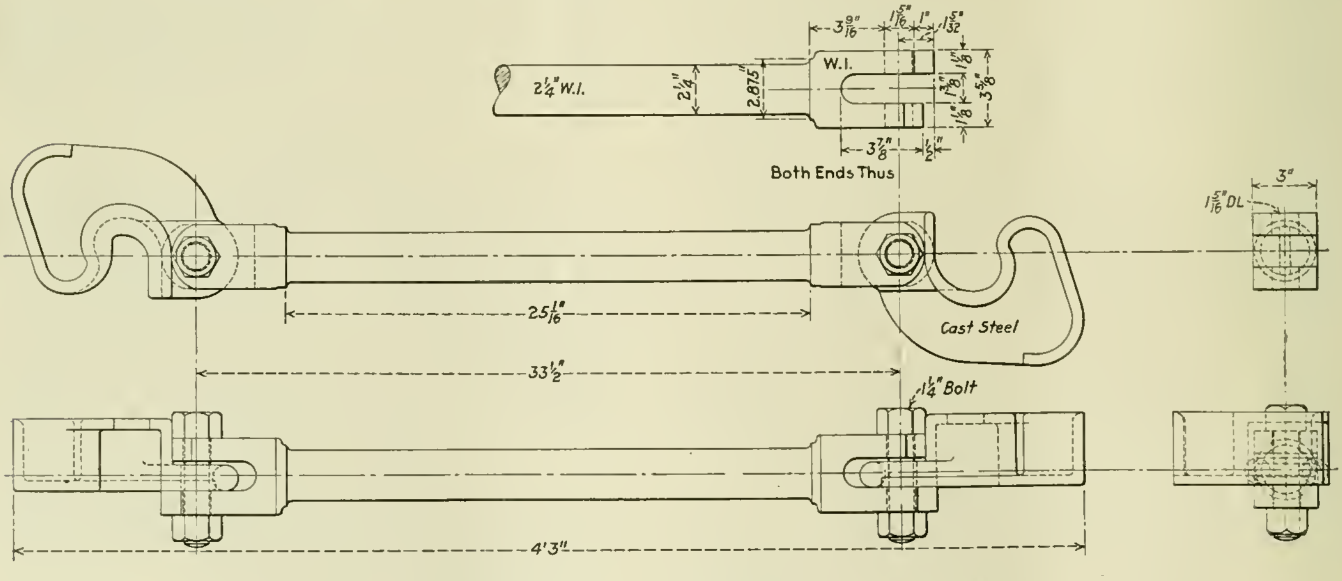
Mix Thermit Thoroughly Before Using

Occasionally Thermit welders find that they are unable to produce the requisite amount of steel from the Thermit which they are using. This is entirely due to the fact that the ingredients (iron oxide and aluminum) have become unmixed. The importance of mixing Thermit thoroughly before using cannot be too strongly emphasized, whether a whole bag or part of a bag is to be used. It is logical that, as the iron oxide is in the form of a flake and the aluminum is in the form of a little round ball, also that as they are so different in specific gravity, they will segregate in the vibration caused by transit. The bag, therefore, should be dumped and the material thoroughly mixed by hand before putting it into the crucible. In a recent case, the Metal & Thermit Corporation, New York investigated the variations in the speed with which Thermit reactions took place. This variation was found to be entirely due to segregation of materials and was entirely eliminated by re-mixing.

An Auxiliary Car Coupler

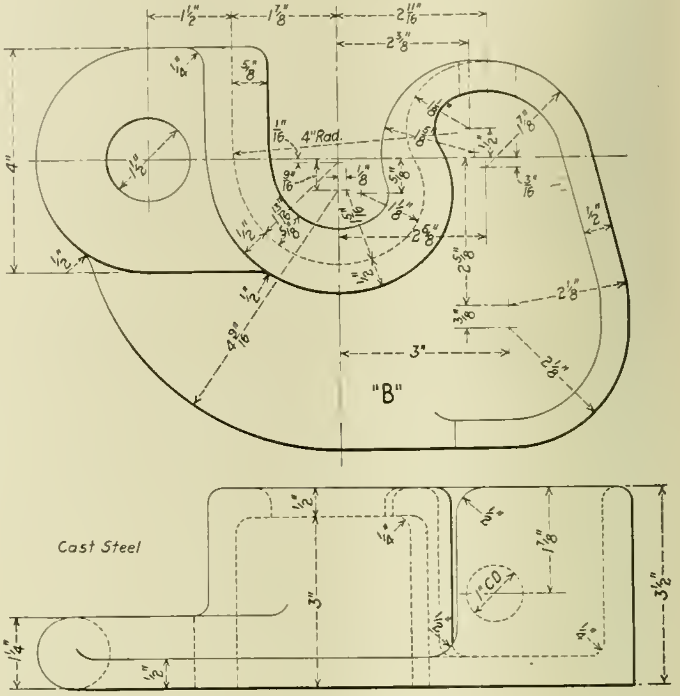
BY NORMAN McCLEOD

In placing cars on tracks leading into industrial plants in cities, considerable difficulty is often experienced because some of the curves are so sharp that the ordinary couplers do not have sufficient clearance to make the sharp turns without fouling. Handling cars with a link between the knuckle pins is not satisfactory and the majority of emergency knuckles are inconvenient to handle. In order to overcome these disadvantages, the auxiliary coupler shown in the drawings was designed.



Auxiliary Coupler, Used for Switching Cars on Sharp Curves

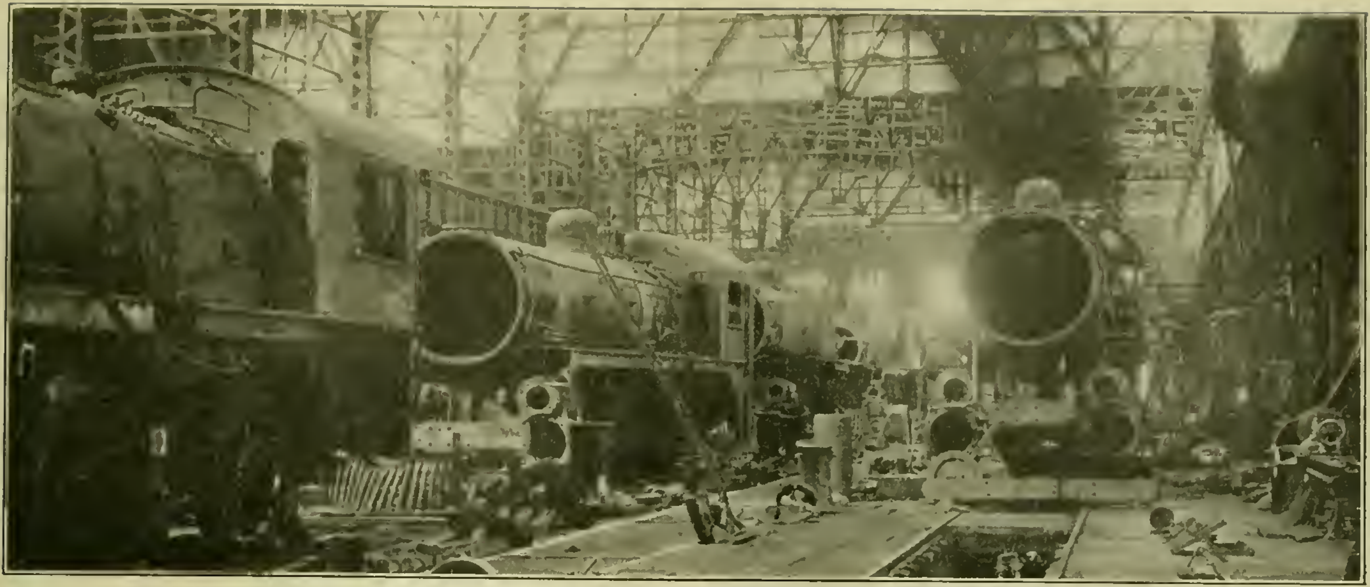
The heads at each end are steel castings, light in section, yet strong enough to stand the stresses imposed upon them in switching. They are made to fit the contour of the standard coupler as shown in the detailed drawing of the head. It will be noted that a flange is provided at the top of the casting. This prevents the head from slipping down through the coupler with which it is engaged and holds it in the proper position while switching. The rod connecting the heads is made of a 2¼ in. wrought iron bar with a clevis on each end.



Detail of the Coupler Head

This device is very useful for placing single cars on sharp curves. It is not intended for handling long cuts, although several cars can be switched with the coupler if occasion requires.

The State Supreme Court of Minnesota, on July 22, held that the United States Railroad Administration is liable for damages resulting from a fire which started on the Great Northern tracks near Cloquet, Minn., and swept into that city in October, 1918, causing a loss of many hundred thousand dollars.



Erecting Shop of Canadian Pacific, Angus, Montreal

No Meeting of Mechanical Division This Year

Reports of Eight Committees Submitted to Letter Ballot of the Members by General Committee

The indefinite postponement of the business meeting of Mechanical Division, American Railway Association, to have been held at the Blackstone Hotel, Chicago, June 29 and 30, has been made permanent for this year. This action was taken after the adoption of the following resolution by the Association of Railway Executives at a meeting held at New York on July 1, 1921:

"*Whereas,* in view of the imperative need for the exercise of all possible economy, it is

"*Resolved* that annual or special meetings or conventions of all organizations under the supervision of this body be indefinitely postponed or curtailed in every possible way."

Following the decision of the General Committee of the Mechanical Division not to hold a meeting of the division this year it was decided to submit to a letter ballot of the members the recommendations of the various committees, the reports of which were to have been presented at the meeting of the division. The letter ballot will close at noon, central time, on Tuesday, September 20.

Abstracts of the reports follow.

Specifications and Tests for Materials

Sub-committees have been appointed and are now actively engaged in work on the subjects assigned.

(*a*) Co-operation with the Rubber Association of America on the preparation of Specifications for Mechanical Rubber Goods.

(*b*) Co-operation with the Equipment Painting Section in the preparation of specifications for paint and painting materials.

(*c*) Specifications for welding wire.

(*d*) Specifications for water gage and lubricator glasses.

(*e*) Revision of present specifications for galvanized sheets.

In addition to the above the chairman has had some correspondence with the chairman of the Train Brake and Signal Committee on the subject of tolerances for air brake and signal hose gaskets and gages for gaskets and couplings, with a view to improving present practice in these particulars. Further work should be done on these subjects during the coming year.

Subjects Referred to the Committee By the General Committee

(*a*) "The proper fibre stress to be employed in the design of helical springs of different diameters of steel wire from ½ in. to 1½ in. in diameter. The original spring table calls for 80,000 lb. per square inch throughout for all sizes, but it is well known that this is not the manufacturers' practice, and, in fact, in many cases it is impossible to obtain a proper spring with the smaller sizes of wire."

A sub-committee was appointed to report on this question, and after investigating the available data on spring design and manufacture, has reported that in its opinion tests should be made to develop information on various grades of steel and different heat treatments. It has not been practicable for your committee to arrange for such tests, nor does it seem at all feasible to make any such arrangements under the present conditions or in the near future. The number of variables affecting spring design, in addition to that of variation in diameter of wire, such as quality of steel, workmanship and heat treatment, makes the whole subject a very indefinite one and one that would require long and expensive investigation, probably without satisfactory results.

The committee will keep this matter before it and will take such action as may be possible.

(*b*) "Heat Treated Axles and Crank Pins. Has the process of heat treatment decreased the number of failures to any appreciable extent?"

The committee feels that it does not have sufficient information to reply to this question, and is endeavoring to obtain the views of other members of the Association by means of a questionnaire.

(c) "Revision of Specifications for Lumber, if such revision is needed. Representatives of the Purchases and Stores Division to be requested to co-operate with the Committee on Specifications and Tests."

No action has been taken on this subject. The committee desires the benefit of advice from all interested members on: (1) What use, if any, is being made of the present Lumber Specifications? and (2) Suggestions for revising the specifications so that they might be of greater use.

Co-operation with the Car Construction Committee

In its report to the Association in June, 1920, the Car Construction Committee made certain recommendations regarding the desired quality of steel for forgings and castings for railroad use, and gave an outline of what, in its opinion, constituted certain fundamental requisites for specifications. Chief among these was the requirements of the elastic limit as a base determination and specifying the elongation in 2 in. and the reduction of area to be controlled by the elastic limit and given constants. Other requirements covered chemical composition and annealing and the recommended constants for tensile properties of two grades of steel with 26,000 and 32,000 lb. per sq. in. elastic limits, respectively.

The committee has spent most of its time at recent meetings in the endeavor to satisfactorily carry out these recommendations of the Car Construction Committee, which have been approved by the Association, and regrets that it has not been entirely successful, partly because of the large amount of work involved in revising the specifications, and partly because of differences of opinion that have arisen between members of our committee and representatives of the Car Construction Committee as to the practicability of certain of the latter's recommendations.

The question of standardizing methods of tests so that results obtained in different laboratories will be comparable is one that is engaging the attention of your committee at this time, and will require its best efforts for some time to come, and also the assistance of all members with laboratories who may be willing to help with the work.

Supplementary Report—Specifications for Chrome Molybdenum Steel Springs

The unsatisfactory condition of Class D bolster springs for trucks of 100,000 lb. capacity cars has been brought to the attention of the Committee on Car Construction, which has prepared designs for alternate springs *L*, *M*, *N* and *O*, to be substituted for present standard springs, classes *B*, *C*, *D* and *H*. The Committee on Car Construction has requested that this committee prepare specifications covering their alternate special springs.

The committee has prepared tentative specifications for chrome molybdenum steel springs, as requested. The committee has not been able to develop any satisfactory information regarding what service may be expected from springs made of chrome molybdenum steel but agrees with the Committee on Car Construction that such springs should be made and tested out in service in order to develop whether they are an improvement over the present carbon steel springs, which have been found to give very unsatisfactory service.

Recommendations

TENTATIVE SPECIFICATIONS

As a result of conferences with representatives of the Car Construction Committee, your committee offers the following specifications and recommendations:

Exhibit A.—A revision of the Standard Specifications for Carbon Steel Axles for Cars, Locomotive Tenders and Engine Trucks.

Exhibit B.—A revision of the present Specifications for Steel Castings for Cars and Locomotives, combining these two into one specification.

It is recommended that the present Specifications for Axles and Steel Castings be retained without change and that both of the above proposed specifications be printed in the proceedings as tentative specifications until further action is justified by the experience of the members in working to them. Your committee feels that this action is warranted by the newness of the proposed method of expressing physical properties, as shown in the Steel Casting Specifications, and the many changes that have been made in the Axle Specifications, as well as by the necessity of having both the consumers and manufacturers become thoroughly familiar with these specifications before they are made obligatory.

Supplementary Report, Exhibit D.—The committee recommends that this specification for Chrome Molybdenum Alloy Steel Helical Springs be adopted as tentative for one year or until further action is recommended by the committee.

CHANGES IN STANDARD SPECIFICATIONS

Exhibit C.—Standard Specifications for Heat Treated Knuckle Pivot Pins to be revised as shown. This increase in the range of both carbon and manganese is recommended to cover the usual grade of steel used for this purpose, as it has been found by experience that the present limits are unnecessarily close.

RECOMMENDED PRACTICE SPECIFICATIONS

The committee does not recommend advancing any of the present Recommended Practice specifications to Standard, for the reason that some changes may have to be made in a number of these if the proposed changes in the method of expressing tensile test requirements develop satisfactorily.

LIMITING THE REVISION OF SPECIFICATIONS

The frequent revision of specifications has been severely criticized by both purchasers and manufacturers, and is clearly an undesirable state of affairs. Therefore, it is recommended that the Association should give serious consideration to establishing a definite time limit for revisions of specifications and other standards which will appear in the Manual, this limit to be preferably three years, during which no changes should be allowed except for reasons important to the interest of the Association and then only if the proposed changes receive at least two-thirds vote at the annual meeting of the Division.

The report is signed by F. M. Waring (chairman), Pennsylvania System; J. R. Onderdonk, Baltimore & Ohio; Frank Zeleny, Chicago, Burlington & Quincy; A. H. Fetters, Union Pacific; H. G. Burnham, Northern Pacific; H. E. Smith, New York Central; J. C. Ramage, Southern Railway; J. H. Gibboney, Norfolk & Western; H. P. Hass, New York, New Haven & Hartford, and G. M. Davidson, Chicago & North Western.

Exhibit A—Proposed Tentative Specifications for Carbon Steel Axles for Cars, Locomotive Tenders and Engine Trucks

1. *Scope.*—Same as Standard Specifications except that paragraph (b), requiring annealing of all axles over 6 in. in diameter at the center, has been omitted.

I—MANUFACTURE

2. *Process*—(a) Steel shall be made by the open hearth or electric process.

(b) All axles over 6 in. in diameter at the center *and axles with* 0.52 *per cent or more carbon* shall be annealed by allowing the finished forgings to become cold after forging, then uniformly reheating to the proper temperature to refine the grain and allowing to cool uniformly.

II—CHEMICAL PROPERTIES AND TESTS

3. *Chemical Composition*—The steel shall conform to the following requirements as to chemical composition:

	Per cent
Carbon, maximum	0.58
Phosphorus, not over	0.05
Sulphur, not over	0.05

4. *Ladle Analyses*—Same as Standard Specifications.
5. *Check Analyses*—Same as Standard Specifications.

III—Physical Properties and Tests

6. *Drop Tests*—(a) Same as Standard Specifications.

(b) The permanent set produced by the first blow shall not exceed that given by the following formula, in which L = length of axle in inches and d = diameter of axle at center in inches.

$$\frac{L}{1.9d} - \frac{d}{2} + \frac{1}{2}\text{ in.}$$

(c) The requirements for five standard sizes of axles based on the above formula are given in the following table:

Classification of axle	Size of journal, in.	Diameter of axle at centre, in.	Length of axle, in.	Height of drop, ft.	Number of blows	Maximum permanent set, in.
A	3¾ by 7	4¼	83¼	18	5	8¾
B	4¼ by 8	4¾	84¼	22½	5	7½
C	5 by 9	5⅜	86½	29	5	6¼
D	5½ by 10	5⅞	88½	34½	5	5½
E	6 by 11	6 7/16	90¼	41½	5	4¾

(d) Same as Standard Specifications.

(e) Same as Standard Specifications.

7. *Drop-test Machine*—Same as Standard Specifications.
8. *Number of Tests*—Same as Standard Specifications.

IV—Workmanship and Finish

9. *Workmanship*—(a) and (b) Same as Standard Specifications.
10. *Finish*—Same as Standard Specifications.

V—Permissible Variations and Weights

11. *Permissible Variation*—Same as Standard Specifications.

VI—Marking and Storing

12. *Marking*—Same as Standard Specifications.
13. *Storing*—Same as Standard Specifications.

VII—Inspection and Rejection

14. *Inspection*—(a), (b) and (c) Same as Standard Specifications.
15. *Rejection*—Same as Standard Specifications.
16. *Rehearing*—Samples tested in accordance with Section 5, which represent rejected material, shall be preserved fourteen days from date of test report. *In case of dissatisfaction with results of test, the manufacturer may make claim for a rehearing within that time.*

Exhibit B—Proposed Tentative Specifications For Carbon Steel Castings

1. *Scope*—(a) These specifications cover annealed and unannealed carbon steel castings for locomotive and car equipment, and for miscellaneous use.

(b) The purposes for which the two grades are generally used are:

Grade A, for castings designed for a low stress.

Grade B, for castings designed for unit stresses of 12,500 to 16,000 lb. per square inch such as truck side frames, bolsters, couplers and coupler parts, locomotive frames, locomotive driving and trailer wheel centers.

I—Manufacture

2. *Process*—The steel may be made by the open-hearth *or any other process approved by the purchaser.*

3. *Annealing*—(a) Grade A steel shall be annealed if the carbon content exceeds 0.30 per cent, or if the manganese content exceeds 0.75 per cent. Grade B steel shall be annealed if the carbon content exceeds 0.22 per cent, or if the manganese content exceeds 0.65 per cent.

(b) Castings of both Grades "A" and "B" of irregular section, and of less carbon or manganese content than specified in paragraph (a), where shrinkage or other internal stresses may be expected, should be annealed.

(c) Castings that require annealing shall be allowed to become cold. They shall then be uniformly heated to the proper temperature to refine the grain and allowed to cool uniformly.

(d) Annealing Lugs.—For the purpose of determining the quality of annealing, at least two and not more than four annealing lugs shall be cast on all castings 150 lb. and over, and on such castings less than 150 lb. as required by the purchaser. The locating of the annealing lugs shall be agreed upon by the inspector and the manufacturer. The standard annealing lug shall be 1 in. in height and 1 in. in width and ⅝ in. in thickness where it joins the casting. The inspector may remove one-half and the manufacturer one-half of the number of annealing lugs.

(e) If, in the opinion of the purchaser or his representative, a casting is not properly annealed, he may at his option require the casting to be reannealed.

II—Chemical Properties and Tests

4. *Chemical Composition*—The steel shall conform to the following requirements as to chemical composition:

Phosphorus, not over	0.05 per cent
Sulphur, not over	0.05 per cent

5. *Ladle Analyses*—An analysis of each melt of steel shall be made by the manufacturer to determine the percentage of carbon, manganese, *silicon*, phosphorus and sulphur. This analysis shall be made from drillings taken at least ¼ in. beneath the surface of a test ingot obtained during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative, when requested, and shall conform to the requirements specified in Section 4.

6. *Check Analyses*—A check analysis may be made by the purchaser from the broken tension test specimen or from a casting representing each melt. The *phosphorus and sulphur* thus determined shall conform to the requirements specified in Section 4. *Determination of carbon and manganese should be made as information to ascertain whether the annealing was in accordance with Section 3 (a).* Drillings for the analysis shall be taken not less than ¼ in. beneath the surface, *and if from a casting shall be taken in such a manner as not to impair its usefulness.*

III—Physical Properties and Tests

7. *Tension Tests*—(a) The steel shall conform to the following minimum requirements as to tensile properties:

	Grade A	Grade B
Elastic limit, lb. per sq. in.	26,000	32,000
Yield point, lb. per sq. in.	29,250	36,000
Product of elastic limit and per cent elongation in 2 in.	700,000 (not less than 22%)	850,000 (not less than 18%)
Product of yield point and per cent elongation in 2 in.	788,000 (not less than 22%)	956,000 (not less than 18%)
Product of elastic limit and per cent reduction of area	975,000 (not less than 33%)	1,200,000 (not less than 27%)
Product of yield point and per cent reduction of area	1,100,000 (not less than 33%)	1,350,000 (not less than 27%)

(b) The ultimate tensile strength shall be reported as information.

(c) Either the elastic limit or the yield point, but not both, shall be determined. The elastic limit called for by these specifications shall be determined by an extensometer reading to at least 0.0002 in. The extensometer shall be attached to the specimen at the gage marks and not to the shoulders of the specimen nor to any part of the testing machine. When the specimen is in place and the extensometer attached, the testing machine shall be operated so as to increase the load on the specimen at a uniform rate. The observer shall watch the elongation of the specimen as shown by the extensometer and shall note for this determination the load at which the rate of elongation shows a sudden increase. The extensometer shall then be removed from the specimen, and the test continued to determine the tensile strength.

(d) The yield point, or the elastic limit, shall be determined at a crosshead speed not to exceed ⅛ in. per minute and tensile strength at a speed not to exceed 1½ in. per minute. The yield point shall be determined by the drop of the beam of the testing machine.

8. *Alternative Tests to Destruction*—In the case of orders including only castings not exceeding 150 lb. in weight, a test to destruction on one casting for each 100 castings or smaller lot may, *at the option of the purchaser*, be substituted for the tension tests. This test shall show the material to be ductile, free from injurious defects, and suitable for the purpose intended. *Castings of minor importance may be accepted on surface inspection.*

9. *Test Specimens*—(a) Same as both Standard Specifications.

(b) An adequate number of test coupons shall be cast with and attached to castings weighing over 150 lb. from each melt when presented for inspection; coupons shall be cast attached to each end of each locomotive frame, to each locomotive cylinder and to each wheel center. If the design of the casting is such that the test coupons cannot be attached, the test bars shall be cast in runners outside of the casting, but attached to it to represent each melt. The location of the test coupons or bars, as well as the method of casting such coupons or bars, shall be subject to mutual agreement by the inspector and manufacturer. In the case of any orders for castings weighing under 150 lb., the physical properties as required in Section 7 may be determined from an extra or spare test bar cast with and attached to some other casting from the same melt.

(c) When sufficient coupons have not been cast, a test specimen may be cut from a finished casting at a location mutually agreed upon by the inspector and manufacturer.

10. *Grouping Melts*—(a) After 15 consecutive melts, which may contain any of all *kinds* of castings (*except frames, wheels centers and cylinders*) covered by these specifications on one or more orders, have been tested and accepted, the manufacturer may group the succeeding melts in lots of five melts each, but each lot not to exceed 40 tons; the entire group to be accepted if the test specimen selected from the lot fulfills the chemical and physical requirements herein specified. If this test fails, a rehearing will be granted on the melt that the failed bar represents, and the other four melts of the group shall be tested individually.

(b), (c) and (d) Same as in Standard Specification for Car Castings.

11. *Number of Tests*—(a) One tension test shall be made from each locomotive frame. One tension test may be made from each wheel center and each locomotive cylinder casting, but at least one of each kind of such castings in each melt shall be tested. For miscellaneous castings from melts which do not include frames, wheel centers or cylinders, one tension test shall be made from each melt except as provided in Section 10 (a).

(b) If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

(c) If the percentage of elongation of any tension test specimen is less than that specified in Section 7 (a) and any part of the fracture is more than ¾ in. from the center of the gage length as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

(d) If the results of physical tests do not conform to the requirements specified, the manufacturer may reanneal the castings but not more than twice. A retest shall be made as specified in Section 7.

(e) No part of these specifications shall operate to cause any one tension to apply to more than 40 tons of castings that are offered for inspection.

IV—WORKMANSHIP AND FINISH

12. *Workmanship*—Same as both Standard Specifications.

13. *Finish*—(a) and (b) Same as both Standard Specifications.

V—MARKING

14. *Marking*—The manufacturer's name or identification mark and the specified pattern number shall be cast on all castings. In addition, the month and the year when made shall be cast on all bolsters, truck sides and similar castings. The location and size of numbers shall be agreed upon by the manufacturer and the inspector. In accordance with the standard practice of the individual foundry, to identify individual castings, a serial number may be cast or the melt number may be stamped on bolsters, truck side and similar castings as agreed upon by the manufacturer and the inspector. The melt number shall be legibly stamped on all other castings weighing over 150 lb.

VI—INSPECTION AND REJECTION

15. *Inspection*—Same as both Standard Specifications.

16. *Rejection*—(a). and (b) Same as both Standard Specifications.

17. *Rehearing*—Samples tested in accordance with Section 6, which represent rejected castings, shall be preserved for two weeks from the date of test report. *In case of dissatisfaction with the results of tests, the manufacturer may make claim for rehearing within that time.*

Exhibit C

It is recommended that the following changes be made in Section 3 of Standard Specifications of Heat Treated Knuckle Pivot Pins.

3. *Chemical Composition*—The steel shall conform to the following requirements as to chemical composition:

	Present Per cent	Proposed change Per cent
Carbon	0.55-0.70	0.55-0.75
Manganese, not over............	0.60	0.70
Phosphorus, not over...........	0.05	0.05
Sulphur, not over..............	0.05	0.05

Exhibit D—Proposed Tentative Specifications for Chrome Molybdenum Alloy Steel Helical Springs

(Classes L, M, N and O, to be substituted for present standard classes B, C, D and H.)

I—MANUFACTURE

1. *Process*—The steel may be made by the open-hearth, crucible or electric furnace process.

II—CHEMICAL PROPERTIES AND TESTS

2. *Chemical Composition*—The steel shall conform to the following requirements as to chemical composition:

Carbon, per cent..................................	.40— .50
Manganese, per cent...............................	.40— .60
Chromium, per cent................................	.80—1.10
Molybdenum, per cent..............................	.30— .50
Phosphorus, maximum, per cent.....................	.04
Sulphur, maximum, per cent........................	.045
Silicon, maximum, per cent........................	.25

3. *Check Analyses*—An analysis may be made by the purchaser from a sample representing each 20,000 lb., or fraction thereof, of each size of spring steel involved. The chemical composition thus determined shall conform to the requirements specified in Section 2.

4. *Sample for Analysis*—(a) If the section is large, a specimen weighing about ½ lb. shall be cut from any part of the spring, or if the spring is small, the entire spring may be taken. If the sample is cut off hot, it shall be cooled in such a way as not to harden it. The inspector shall stamp the sample with his private mark as soon as it is cut off.

(b) The drillings for check analysis shall be made from the sample so selected; the drill to be approximately one-half the diameter of the wire. The drillings shall be mixed from the total drillings obtained by passing entirely through the section of the wire.

III—PHYSICAL PROPERTIES AND TESTS

5. *Physical Tests*—(a) The properties specified in paragraphs (b), (c), (d) and (e), shall be determined in the order specified. The spring shall not be rapped or otherwise disturbed during the test.

(b) *Solid Height*—The solid height is the perpendicular distance between the plates of the testing machine when the spring is compressed solid with a test load of at least one and one-quarter times that necessary to bring all coils in contact. The solid height shall not exceed that specified by more than 1/16 in.

(c) *Free Height*—The free height is the height of the spring when the load specified in paragraph (b) has been released, and is determined by placing a straight-edge across the top of the spring and measuring the perpendicular distance from the plate on which the spring stands to the straight-edge at the approximate center of the spring. The free height shall not exceed that specified by more than ⅛ in.

(d) *Loaded Height*—The loaded height is the difference between the plates of the testing machine when the specified working load is applied. The loaded height shall not vary more than 1/32 in. under that specified.

(e) *Permanent Set*—(1) The permanent set is the difference, if any, between the free height and the height after the spring has been compressed solid three times in rapid succession, with the test load specified in paragraph (b), measured at the same point and in the same manner. The permanent set shall not exceed 1/32 in.

(2) If there is any permanent set not exceeding 1/32 in. the difference between the free height and the height after the test load of 1½ times the specified working load has been applied and fully released two additional times, shall not be greater than the permanent set first measured.

6. *Number of Tests*—(a) A lot for physical test shall consist of not more than 500 individual coils, regardless of the grouping.

(b) From each lot of springs which has met the requirements of Sections 8 and 9, the purchaser or his representative may select for physical test at least 10 per cent, to be tested in accordance with the requirements of Section 5.

7. *Retests*—If any of the springs representing a lot fail to meet the requirements as to physical properties specified in Section 5, but at least one-half of the springs representing a lot do meet these requirements, each spring of the lot shall be tested, and those which meet the requirements shall be accepted. If more than one-half of the springs representing a lot fail to meet the requirements specified in Section 5, the lot will be rejected.

IV—PERMISSIBLE VARIATIONS

8. *Bars*—The gage of the bars shall be within the limits as specified in A. R. A. Specifications for Carbon Steel Bars for Railway Springs.

Footnote—A suggested heat treatment is as follows:

(a) The coiling should be done at temperatures between 1,700 degrees F. and 1,800 degrees F., and the steel shall be cooled slowly in air, not quenched from the coiling heat, until black.

(b) Springs should be reheated after coiling to a temperature of 1,525 degrees F. to 1,575 degrees F., and quenched in oil.

(c) Springs should be removed from the oil when at a temperature of about 300 degrees F. and either allowed to cool slowly in air or immersed immediately in the drawing bath. The springs should be drawn as soon as possible after quenching.

(d) The drawing should be done in a salt bath at a temperature of 940 degrees F. to 960 degrees F., and the springs should be allowed to remain in the bath and at that temperature for at least one hour.

9. *Springs*—The outside dimensions of the springs, excepting the height, shall not vary more than 1/16 in. from that specified.

V—Workmanship

10. *Workmanship*—(a) The springs shall be of a uniform pitch. The ends shall be tapered to present a flat bearing surface of at least two-thirds the circumference, at right angles to the axis of the springs within a tolerance of ⅛ in, to the foot.

(b) The spring bars shall be free from seams, excessive scale, roll marks or scratches which may constitute injurious defects.

VI—Marking

11. *Marking*—(a) The name or brand of the manufacturer, the year and month of manufacture and, if specified, the purchaser's class number, shall be legibly stamped on each spring at a place not detrimental to the life of the spring.

(b) Any stamping by the inspector shall be so placed as not to be detrimental to the life or service of the spring.

VII—Inspection and Rejection

12. *Inspection*—(a) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the springs ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities and necessary assistance to satisfy him that the springs are being furnished in accordance with these specifications.

(b) The purchaser may make the tests to govern the acceptance or rejection of the material in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

(c) All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

13. *Rejection*—(a) Material represented by samples which fail to conform to the requirements of these specifications will be rejected.

(b) Individual springs which, subsequent to the above tests at the mills or elsewhere and their acceptance, show defects or imperfection will be rejected and shall be replaced by the manufacturer.

14. *Rehearing*—Samples tested in accordance with Section 3, which represent rejected material, shall be held for two weeks from the date of test report. In case of dissatisfaction with the results of tests, the manufacturer may make claim for a rehearing within that time.

15. *Reworking*—Any springs which fail to meet the requirements of the physical tests or conform to the specified dimensions may be again submitted after being reworked.

Joint Committee on Joint Inspection of Standard Materials

A joint committee, representing the Mechanical and Purchases and Stores Sections, took up the question of co-operative inspection of standard materials at a meeting in Chicago on February 24, at which two methods of handling such a scheme were brought out: First, a regional plan whereby the roads with inspection forces would handle all inspection for other roads in certain regions; second, a central bureau of inspection organized and operated by the American Railway Association but without testing laboratories.

With either plan the roads interested must necessarily agree on uniform material specifications which would naturally be those of the association covering such standard materials as air-brake and signal hose, air coupling gaskets, couplers and coupler parts, axles, springs, wheels, side frames, bolsters, brake beams and journal bearings.

The majority of the committee is of the opinion that the regional plan of inspection by certain roads for others would not work out satisfactorily, primarily because the sources of material are largely confined to a restricted area and the burden would fall upon a comparatively few roads operating in that area. These roads would have to increase their inspection and testing facilities, and, further, such an increase in their work might result in discrimination in favor of their own material under certain conditions of pressure for material.

The central bureau of inspection under the control of the association appears to possess the greatest practical value, provided always that the railroads now purchasing material without inspection can be brought into the organization and made to stand their pro rata share of the expense. The manager of such a bureau should have authority to rule on all disputes between his inspectors and manufacturers, and there should be no appeal from his decision.

The roads now inspecting their own standard parts would have to agree to turn this part of their work over to the central bureau and stand their share of the expense, continuing their own inspection forces on other material. For certain large railroads this would indicate additional expense without benefit, but experience may prove otherwise.

It is recommended that the association sound out its members to ascertain their willingness to co-operate on either of the two plans outlined above.

F. M. Waring was chairman of the committee.

Report of Arbitration Committee

During the year Cases 1167 to 1183, inclusive. have been decided and copies sent to the members. These decisions are made part of this report. A vote of concurrence is requested.

With the approval of the General Committee, this committee has continued the rendering of interpretations of such questions as have been asked by the members regarding the Rules of Interchange. The more important of these interpretations have been issued to the members in Supplement No. 1 to the 1920 Rules of Interchange.

All recommendations for changes in the Rules of Interchange submitted by members, railroad clubs, private car owners, etc., have been carefully considered by the committee and, where approved, changes have been recommended.

RECOMMENDED CHANGES IN THE RULES OF INTERCHANGE

Preface

In order to more clearly indicate the spirit and intent of the Rules of Interchange the committee recommends that the preface to the rules be modified in accordance with the proposed form shown below:

> These rules are formulated as a guide to the fair and proper adjustment of all questions arising between car owner and handling company with the intent of:
>
> 1. Making car owners responsible for, and therefore, chargeable with the repairs to their cars necessitated by ordinary wear and tear in fair service; by the Safety Requirements and by the Standards of the American Railway Association.
>
> 2. Placing responsibility with and providing a means of settlement for damage to any car, occurring through unfair usage or improper protection by the handling company.
>
> 3. Providing an equitable basis for charging such repairs and damages.
>
> Inspection of freight cars for interchange and method of loading will be in accordance with this Code of Rules and the Specifications for Tank Cars and Loading Rules issued by this Association.

RULE 2

The committee recommends that the fourth paragraph of Section (b) of this rule be modified in accordance with the proposed form shown below in order more definitely to cover the intent of the requirement:

> Cars using lighting outfits operated by *engines using inflammable liquids with flash point 80° F. or lower, such as gasoline, motor fuel and alcohol,* will not be accepted in interchange. *This will not apply to lighting outfits operated by petroleum oils with flash point above 80° F., such as kerosene or illuminating oil.*

RULE 3

The committee recommends that the second paragraph of Section (h) of this rule be eliminated.

The committee recommends that the effective date of Section (i) be extended to October 1, 1923.

The committee recommends that Section (l) be modified to correspond with the Loading Rules for maximum spacing dimension for side stake pockets on flat cars and that the effective date of this requirement be extended to January 1, 1923, as follows:

> All flat cars that can be used for twin or triple shipments of lading, built after January 1, 1918, must have side stake pockets spaced minimum 2 ft. 0 in. and maximum *4 ft.* After *January 1, 1923,* no flat car that can be used for twin or triple shipments will be accepted in interchange unless the side pockets are so spaced.

RULE 9

The committee recommends that the following paragraph be omitted from Rule 9 as this requirement is already provided for in the item of "Air Brakes Cleaned":

> When triple valve and cylinder are cleaned, the initial of road and date of last previous cleaning must be shown.

The committee recommends that requirement for showing location be added to item covering metal brake beams R. & R., making this item to read as follows:

Metal brake beams, R. & R....	New or second-hand, applied. If A. R. A., and number of same, or non-A. R. A. Make or name. Cause of removal. *Location number (see Rule 14).*

RULE 14

The committee recommends that the following be added to the second paragraph of this rule:

> *The same order of numbers shall be used for designating corresponding location of brake beams. In any case where a right or left side is designated on defect, billing repair or joint evidence cards for other parts of cars, the same uniform order of location shall govern.*

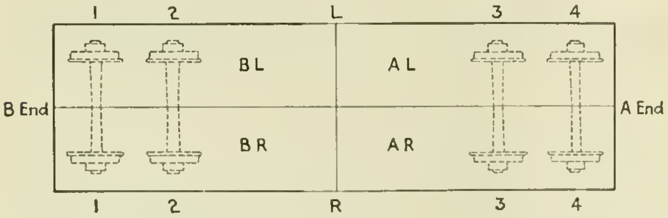


Illustration of Method of Designating the Location of Parts on Car Specified in Rule 14

The committee recommends that the accompanying figure be added to this rule.

RULE 19

The committee recommends that the following paragraph be added to Rule 19:

> *Plain cast-iron brake shoes should not be used. New reinforced back brake shoes must be used to justify bill.*

RULE 22

In order to define the intent of this rule more clearly, the committee recommends that the second paragraph be modified to read as follows:

> *Longitudinal sills may be spliced at both ends; intermediate or side sills on either side of the body bolster.* The nearest part of the splice must not be less than 12 in. from edge of body bolster. Intermediate sills, spliced between body bolster and cross-bearer, must be reinforced as per Figs. 11 or 11-A. Intermediate sills, spliced between bolster and end of car, and side sill, spliced on either side of bolster, must be in accordance with Figs. 10 or 10-A, preferably the latter.

RULE 23

It is evident from the questions referred to the committee that Section IV of this rule is more or less confused. In order to clarify the intent of this rule, the committee recommends that Section IV be modified in accordance with the proposed form shown below:

Welding cracks or fractures will be permitted on the following:
Car and roof sheets.
*Cast steel truck sides.
*Pressed and structural steel truck sides, bolsters and transoms.
*Cast steel bolsters.
Draft castings.
*Brake beams.
*Cast steel coupler yokes.
Car sills, posts, braces, stakes, carlines, side plates and end plates.

Other car parts subject to compression only, and those not subject to high tension strains, except as otherwise prohibited.

*Welding is permitted only when the area of the crack is less than two-fifths, or 40 per cent, of the total area through the section at the point of fracture, but it is not permissible to weld any crack located within 6 in. of an old weld.

RULE 49 (Owners Responsible)

The committee recommends that Rule 49 be modified to read in accordance with the proposed form shown below:

> (1) *All steel cars not equipped with cardboards for defect cards and joint evidence cards. Same to be located either on cross tie under car or inside of side sill at end of car, or on center sill of cars equipped with center sills only. Size of card to be not less than 5½ by 9 in.*
>
> (2) *All steel cars not equipped with cardboards for Bad Order cards, routing cards, return cards, etc. Same to be located on each side of car, near bottom at left hand end, or on end of end sill, and on center sill on cars equipped with center sills only. Size of cardboard to be not less than 5½ by 9 in.*
>
> (3) *Steel box cars not equipped with cardboards for special explosive and other placards, as required by the I. C. C. Same to be located on side doors and both ends of car. Size to be not less than 12 by 12 in.*
>
> (4) *All cardboards on steel cars must be secured with rivets or bolts with ends riveted over nuts.*

RULE 56

In view of the fact that cars will not now be accepted in interchange unless equipped with all metal brake beams, it is recommended that Rule 56 be eliminated from the Rules of Interchange.

RULE 57 (Delivering Company Responsible)

The committee recommends that Rule 57 be modified to read in accordance with the proposed form shown below:

> Cars not equipped with A. R. A. standard 1⅜-in. air brake hose. For label, see page 71.
>
> The use of a rectangular label in addition to the band label is optional with any railroad, providing space, *preferably 2 in., is allowed between the two labels.*

RULE 59 (Delivering Company Responsible)

The committee recommends that a new rule be added to the Rules of Interchange to be designated as Rule No. 59 to read as follows:

Cars offered in interchange with missing dirt collectors where cars are stenciled that they are so equipped.

Rule 60

The committee recommends that the following be added to the last paragraph of this rule:

The stenciling showing air brakes cleaned must not be changed unless all work is properly performed as required by the standard instructions for Annual Repairs to Air Brakes on Freight Cars.

Rule 62

The committee recommends that the second paragraph of Rule 62 be modified to read in accordance with proposed form shown herewith.

Proposed Form

In replacing brake shoes on foreign cars, new *reinforced back* shoes must be used to justify bill.

Rule 66

The committee recommends that this rule be changed to provide that the expense of periodical repacking of journal boxes shall be assumed by the handling line and that item of lubrication be restored in Rules 1 and 108.

Rule 86

The committee recommends that the effective date of fourth paragraph of Section (b) of this rule be extended to October 1, 1922.

Rule 87

In order to show clearly the intent of this rule, the committee recommends that reference to Rule 70 be eliminated in the first paragraph and that the second paragraph be changed to read as follows:

The company making such improper repairs must place upon the car, at the time and place the work is done, an A. R. A. defect card, which card must state the wrong repairs made, *and which will be authority for bill for both material and labor for correcting the wrong repairs.*

Rule 88

In order to clearly show the intent of this rule, the committee recommends that the first paragraph be modified as shown below:

In order that repairs of owners' defects may be expedited as fully as possible, foreign or private line cars may be repaired by the handing line by using material from their own stock instead of ordering *from owner special material not specified in last paragraph of Rule* 122, in which event the repairing line must issue its defect card for the labor only of correcting such improper repairs, and defect card should be so marked.

Rule 112

Upon recommendation from the Committee on Car Construction the Arbitration Committee recommends that a fourth paragraph be added to Class E under the table showing reproduction cost per pound for freight equipment, reading as follows:

All wood, equipped with metal draft arms, extending 24 inches or more beyond center line of body bolster and with body bolster of sufficient strength to transmit buffing and pulling shocks to all longitudinal sills.

The reference to draft arms in Note 1 should be eliminated.

Section (d), which was intended to provide for settlement covering so-called rebuilt cars, has been found to be impracticable of application. The committee recommends the abrogation of this provision and the substitution of a new Section (d) reading as follows:

If construction of car has been altered to the extent of placing it in a higher class for which a higher rate per pound is allowed under section (b), settlement shall be made at such higher rate per pound and according to the stenciled lightweight on car at date of destruction, and the depreciation shall be figured from date car was originally built at the rate applying to car as destroyed. This provision shall be retroactive in application to unsettled cases under the 1920 *Rules.*

All references to rebuilt cars in this rule should be eliminated.

Rule 114

In view of the adoption by special letter ballot of the proposition of replacing ends of cars when broken out, the committee recommends that this rule be modified in accordance with proposed form shown below:

If the company on whose line the car is destroyed elects to rebuild the car, the original plan of construction must be followed, and the original kind and quality of materials used, except that metal draft arms extending beyond body bolster, steel draft members extending full length of car, transom draft gear, steel center sills or steel underframe should be applied and be of such design as will meet the recommended practice of the Division for reinforcing existing cars.

On house cars (other than refrigerator cars) with steel underframes or steel center sills, having a center sill area of not less than 24 *sq. in., when an end requires repairs consisting of new posts and braces, the ends shall be replaced with ends specified for new cars, this to be done by or under the direction of the car owner.* No allowance shall be made for betterments not authorized by car owner.

Note.—See Per Diem Rule 8.

Rule 120

The committee recommends that the following changes and additions be made in this rule:

Add the following item in the table under "Flat Cars," Section (b):

All steel or steel underframe........................$150.00

Change Section (c) to read as follows:

(c) The owner shall authorize repairs or destruction of car *within 30 days from date of notification.*

Add the following paragraph to Section (e):

At the time of authorizing destruction the owner shall furnish handling line statement showing estimated weights of material in car for which credit is due to assist handling line in arriving at proper credit. Couplers, wheels, axles and journal bearings shall be credited on basis of scrap prices shown in Rule 101 *for such items.*

Insert the following paragraph between the present first and second paragraphs of Section (f):

On house cars (other than refrigerator cars) with steel underframes or steel center sills, having a center sill area of not less than 24 *sq. in., when an end requires repairs consisting of new posts and braces, the ends shall be replaced with ends specified for new cars, this to be done by or under the direction of the car owner.*

PASSENGER CAR RULES

Rule 2

The committee recommends that Section (b), Rule 2, be modified as shown below, in order to more clearly define the intent of this requirement:

Cars, loaded or empty, using lighting outfits operated by engines using *inflammable liquids with flash point* 80° *F. or lower, such as gasoline, motor fuel and alcohol,* will not be accepted in interchange. *This will not apply to lighting outfits operated by petroleum oils with flash point above* 80° *F., such as kerosene or illuminating oil.*

Rule 12

The committee recommends that Section (b) of this rule be modified as shown below:

The billing repair card must specify for journal bearings applied and removed, whether solid, filled or other kind, length of journal and box number *as marked on truck.*

The report is signed by T. H. Goodnow (Chairman), Chicago & North Western; J. J. Hennessey, Chicago, Milwaukee & St. Paul; J. Coleman, Grand Trunk; F. W. Brazier, New York Central; J. E. O'Brien, Missouri Pacific; T. W. Demarest, Pennsylvania System, and G. F. Laughlin, Armour Car Lines.

Prices for Labor and Material

During the past year the committee has made certain investigations, and submits the following report on freight car Rules 101, 107, 111 and 112, and Rules 21 and 22 of the passenger car code.

The material prices set forth in the accompanying recommendations for 1921-22 rules are based on the average prices paid by five large representative roads during 1920, supplemented by numerous current quotations from several large railway supply houses. As in the present code, all material prices include suitable allowances to cover freight transportation charges, direct and indirect store expense, fabricating labor when involved, and interest on stock investment, based on average monthly inventory balance multiplied by interest rate and result divided by total annual material disbursements.

In recommending many of the material prices, due consideration was given to the fact that the roads had stocked up on materials at prices effective before the decline, and therefore the full effect of the recent decline in prices will not be represented in the prices recommended for next year.

In establishing prices for practically all second-hand materials, the same percentage of cost new as prevails in the present rules was used. Scrap materials were averaged and current market prices less transportation charges to scrap plant were set up as credits.

Labor allowances shown in hours and tenths are substantially the same as those in the present code, which were based on time studies in 1915 and 1916, one of the most important exceptions being the fact that certain allowances for sills, bolsters, etc., which in the present code include jacking of the car, have been modified so that the jacking cost is omitted and is to be added as a separate operation where consistent. It is felt that this will be of considerable advantage to bill clerks throughout the country in that there will be removed the necessity for deducting under certain combinations the jacking price heretofore included in two or more of the operations in the combination.

The principal labor rate per hour (Item 172, Rule 101), is recommended at $1.20; the same as authorized in the existing rules. As noted above, no changes have been made in the labor allowances as a whole nor in the rates per hour, this for the reason that overhead studies made on six representative roads during October and November, 1920, also investigations made in February and March, 1921, as to actual time consumed on these roads in performing the work as compared to the arbitrary allowances authorized under the rules, indicate that the roads of the country, on the average, are being fairly compensated under the rules for the work performed by them on foreign cars.

The report is signed by A. E. Calkins (chairman), New York Central; Ira Everett, Lehigh Valley; T. J. Boring, Pennsylvania System; I. N. Clark, Grand Trunk; H. G. Griffin, Morris & Company; J. H. Milton, Chicago, Rock Island & Pacific; C. N. Swanson, Atchison, Topeka & Santa Fe; E. H. Weigman, Louisville & Nashville, and A. E. Smith, Union Tank Car Company.

RULE 1C

[The important changes in this rule are increases in most of the prices for air brake material, decreases in the prices for couplers and coupler parts and the discontinuance of price for the periodical repacking of journal boxes.—EDITOR.]

RULE 107

The committee recommended the change of the first paragraph of Rule 107 to read as follows:

> The following table shows the labor charges which may be made for performing the various operations shown. The labor allowances include all work necessary to complete each item of repairs, *unless the rules specifically provide that in connection with the operation additional labor may be charged for the R. & R. or R. of any item which must necessarily be R. & R. in connection therewith.*

[The changes in time allowances are largely confined to reductions due to not including jacking of the car in operations which generally require the car to be raised.—EDITOR.]

RULE 111

[The principal change in this rule is the elimination of item 8, tightening cylinder and reservoir when loose.—EDITOR.]

PASSENGER CAR RULES 21 AND 22

[Item 3A was added to Rule 21, allowing one hour for slackening buffer in order to R. & R. or R. coupler knuckle, lock or pin. A number of adjustments in material prices are shown in Rule 22.—EDITOR.]

Report of Car Construction Committee

Salt Water Drippings

Conference has been held with representatives of the principal interests using brine valves and it is the opinion that the various devices now used will, with proper maintenance, perform their functions, that the users of such devices are fully advised as to their necessity and should be notified that they must have all cars with brine tanks equipped by January 1, 1922, and that no further extension of time will be granted after that date. It is recommended that paragraph "F" of Interchange Rule 3 be modified to correspond with the above.

End Doors for Box Cars

In the report of 1920 the following recommendation was overlooked when preparing the sheet for letter ballot:

> In 1913, the Master Car Builders' Association adopted as recommended practice, that end doors must be so constructed that, when closed, they lock automatically by means of a lock accessible from the inside of the car, thus avoiding the necessity of taking seal records. Sheet 30 shows a design of inside fastening which is not automatic, and your committee recommends that recommended practice adopted in 1913 should be advanced to standard, and that the design of inside latch shown on Sheet F should be removed, and a note substituted that the fastening should lock the door automatically from the inside of the car.

It is recommended that this be now submitted to letter ballot.

Minimum Thickness for Backs of Journal Bearings

Requests to fix a minimum thickness, because, at times, too much wear is allowed before removal, led to issuing Circular No. S III—108, asking whether such limits are necessary, and, if so, what the limits should be.

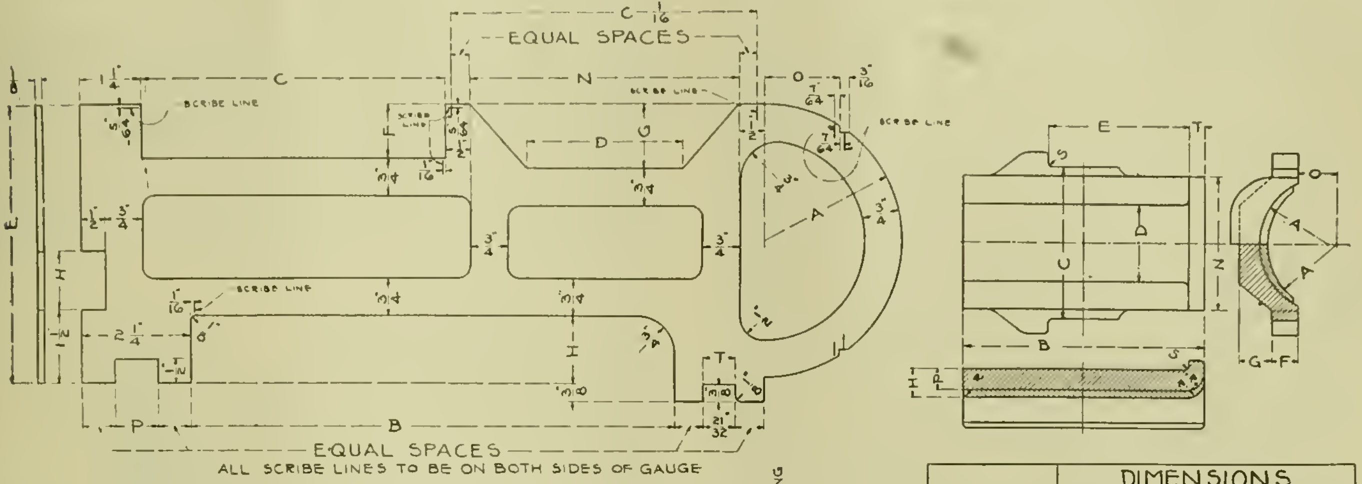
According to the majority of replies received, it is desired to fix a standard minimum thickness for backs of journal bearings, as follows:

Class of Bearing	A	B	C	D	E	F
Size of journal, in.	3¾ by 7	4¼ by 8	5 by 9	5½ by 10	6 by 11	6½ by 12
Min. Thickness of back, in.	½	9/16	5/8	11/16	¾	13/16

It is suggested that this be adopted as recommended practice.

Gages for Bearings and Wedges

Attention was directed to a growing demand for these gages and that standards should be provided. The committee's recommendations for such gages are shown in Figs. 1 and 2 and it is suggested that these be adopted as recommended practice, the present separate gages to remain as standard.



A R A CLASSIFICATION	SIZE OF JOURNAL	DIMENSIONS- INCHES										
		A	B	C	D	E	F	G	H	N	O	P
A	$3\frac{3}{4}" \cdot 7"$	$1\frac{57}{64}$	$6\frac{25}{32}$	$4\frac{17}{32}$	$2\frac{1}{32}$	$3\frac{31}{32}$	$\frac{29}{32}$	$1\frac{1}{8}$	$1\frac{1}{16}$	$3\frac{25}{32}$	$\frac{57}{64}$	$\frac{3}{4}$
B	$4\frac{1}{4}" \times 8"$	$2\frac{9}{64}$	$7\frac{25}{32}$	$4\frac{29}{32}$	$2\frac{11}{32}$	$4\frac{15}{32}$	$\frac{7}{8}$	$1\frac{9}{32}$	$1\frac{1}{16}$	$4\frac{13}{32}$	$1\frac{1}{64}$	$\frac{3}{4}$
C	$5" \cdot 9"$	$2\frac{33}{64}$	$8\frac{25}{32}$	$5\frac{21}{32}$	$3\frac{5}{32}$	$5\frac{5}{32}$	$1\frac{1}{16}$	$1\frac{7}{32}$	$1\frac{3}{16}$	$4\frac{29}{32}$	$1\frac{25}{64}$	$\frac{7}{8}$
D	$5\frac{1}{2}" \cdot 10"$	$2\frac{49}{64}$	$9\frac{25}{32}$	$6\frac{5}{32}$	$3\frac{5}{32}$	$5\frac{21}{32}$	$1\frac{3}{32}$	$1\frac{5}{16}$	$1\frac{3}{16}$	$5\frac{13}{32}$	$1\frac{33}{64}$	$\frac{7}{8}$
E	$6" \times 11"$	$3\frac{1}{64}$	$10\frac{25}{32}$	$7\frac{5}{32}$	$3\frac{17}{32}$	$6\frac{19}{32}$	$1\frac{9}{32}$	$1\frac{1}{2}$	$1\frac{5}{16}$	$6\frac{9}{32}$	$1\frac{33}{64}$	1
F	$6\frac{1}{2}" \cdot 12"$	$3\frac{17}{64}$	$11\frac{25}{32}$	$7\frac{21}{32}$	$4\frac{1}{32}$	$7\frac{3}{32}$	$1\frac{15}{32}$	$1\frac{9}{16}$	$1\frac{7}{16}$	$6\frac{17}{32}$	$1\frac{41}{64}$	$1\frac{1}{8}$

DIMENSION 'P' ASSUMES $\frac{5}{16}$ LINING

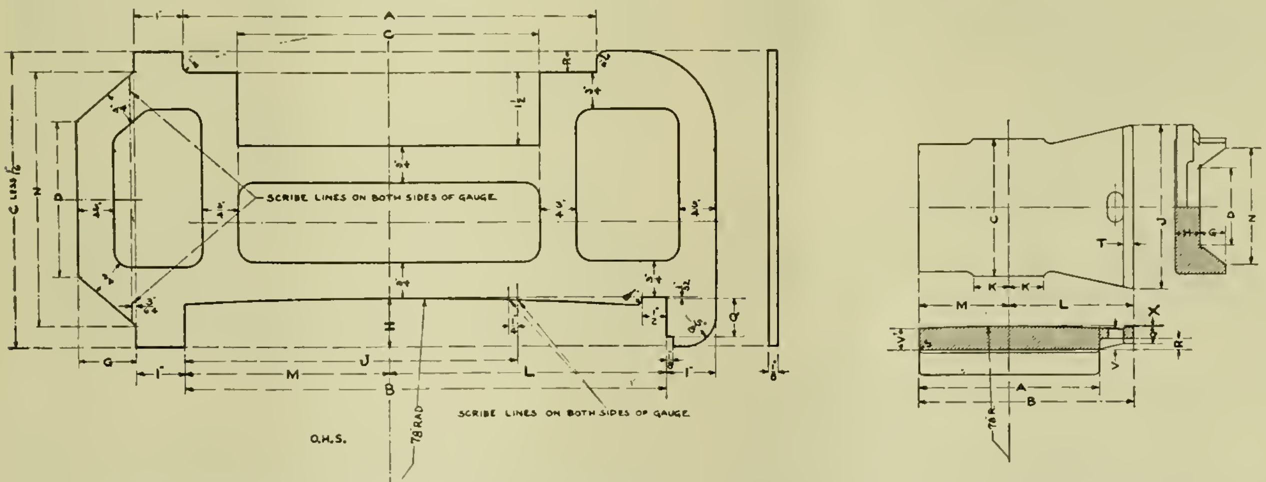
	DIMENSIONS											
	A	B	C	D	E	F	G	H	P	R	S	T
MAY BE GREATER BY	$\frac{1}{32}"$	$\frac{1}{32}"$	$\frac{1}{32}"$	$\frac{1}{32}"$	$\frac{1}{16}"$	$\frac{1}{32}"$	$\frac{3}{64}"$	$\frac{1}{16}"$	$\frac{1}{16}"$	$\frac{1}{16}"$	0	$\frac{1}{32}"$
MAY BE LESS BY	$\frac{1}{64}"$	$\frac{1}{32}"$	$\frac{1}{32}"$	$\frac{1}{32}"$	$\frac{1}{32}"$	$\frac{3}{64}"$	0	$\frac{1}{32}"$	0	0	$\frac{3}{32}"$	$\frac{1}{16}"$

Fig. 1—Journal Bearing Gage

Dust Guards

Since pressed or cast steel and malleable iron journal boxes with round bottom dust guard cavities have come into more general use, it is advisable, in order to avoid duplicating reserve stock for repairs, to make the bottom of all dust guards semicircular. Such dust guards can be used in boxes with either square or round bottom dust guard cavities.

The committee recommends that the dust guard shown in Fig. 3 be made standard. The dust guards illustrated show the round bottom and otherwise were changed in dimensions to better fit the standard journal boxes.

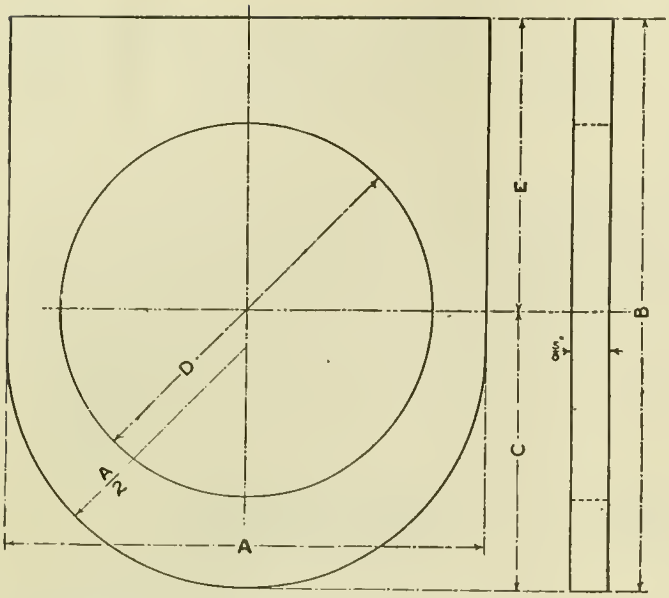


A.R.A. CLASSIFICATION	SIZE OF JOURNAL	DIMENSIONS IN INCHES											
		A	B	C	D	G	H	J	L	M	N	Q	R
A	$3\frac{3}{4} \times 7"$	$5\frac{7}{16}$	$6\frac{19}{32}$	$4\frac{17}{32}$	$2\frac{1}{16}$	1	$\frac{25}{32}$	$5\frac{1}{8}$	$3\frac{7}{8}$	$2\frac{23}{32}$	$3\frac{5}{8}$	$\frac{23}{32}$	$\frac{3}{16}$
B	$4\frac{1}{4}" \times 8"$	$6\frac{7}{16}$	$7\frac{25}{32}$	$4\frac{29}{32}$	$2\frac{11}{32}$	$1\frac{1}{16}$	$\frac{29}{32}$	$5\frac{1}{8}$	$4\frac{9}{16}$	$3\frac{7}{32}$	$4\frac{1}{16}$	$\frac{27}{32}$	$\frac{3}{16}$
C	$5" \times 9"$	$7\frac{7}{16}$	$8\frac{25}{32}$	$5\frac{21}{32}$	$3\frac{3}{16}$	$1\frac{1}{16}$	$1\frac{1}{32}$	$6\frac{7}{8}$	$5\frac{1}{16}$	$3\frac{23}{32}$	$4\frac{3}{4}$	$\frac{23}{32}$	$\frac{7}{16}$
D	$5\frac{1}{2}" \times 10"$	$8\frac{7}{16}$	$9\frac{27}{32}$	$6\frac{5}{32}$	$3\frac{3}{16}$	$1\frac{3}{16}$	$1\frac{1}{32}$	$6\frac{7}{8}$	$5\frac{5}{8}$	$4\frac{7}{32}$	$5\frac{7}{32}$	$\frac{23}{32}$	$\frac{7}{16}$
E	$6" \times 11"$	$9\frac{7}{16}$	$10\frac{27}{32}$	$7\frac{5}{32}$	$3\frac{9}{16}$	$1\frac{3}{8}$	$1\frac{5}{32}$	$7\frac{7}{8}$	$6\frac{1}{8}$	$4\frac{23}{32}$	$6\frac{1}{8}$	$\frac{25}{32}$	$\frac{1}{2}$
F	$6\frac{1}{4}" \times 12"$	$10\frac{7}{16}$	$11\frac{27}{32}$	$7\frac{21}{32}$	$4\frac{1}{16}$	$1\frac{1}{2}$	$1\frac{13}{32}$	$8\frac{3}{8}$	$6\frac{5}{8}$	$5\frac{7}{32}$	$6\frac{7}{16}$	$\frac{7}{8}$	$\frac{21}{32}$

	DIMENSIONS																	
	A	B	C	D	G	H	J	K	L	M	N	Q	R	S	T	V	V'	X
MAY BE GREATER BY	$\frac{1}{16}"$	$\frac{1}{32}"$	$\frac{1}{32}"$	$\frac{1}{32}"$	0"	$\frac{1}{32}"$	$\frac{1}{8}"$	$\frac{1}{8}"$	$\frac{1}{32}"$	$\frac{1}{32}"$	$\frac{1}{32}"$	0"	$\frac{1}{16}"$	$\frac{1}{16}"$	$\frac{1}{16}"$	$\frac{1}{32}"$	$\frac{1}{32}"$	$\frac{1}{32}"$
MAY BE LESS BY	$\frac{1}{16}"$	$\frac{1}{32}"$	$\frac{1}{32}"$	0"	$\frac{3}{64}"$	$\frac{1}{16}"$	$\frac{1}{8}"$	$\frac{1}{8}"$	$\frac{1}{16}"$	$\frac{1}{16}"$	0"	$\frac{1}{16}"$	$\frac{1}{16}"$	$\frac{1}{16}"$	$\frac{1}{16}"$	$\frac{3}{32}"$	$\frac{3}{32}"$	$\frac{1}{32}"$

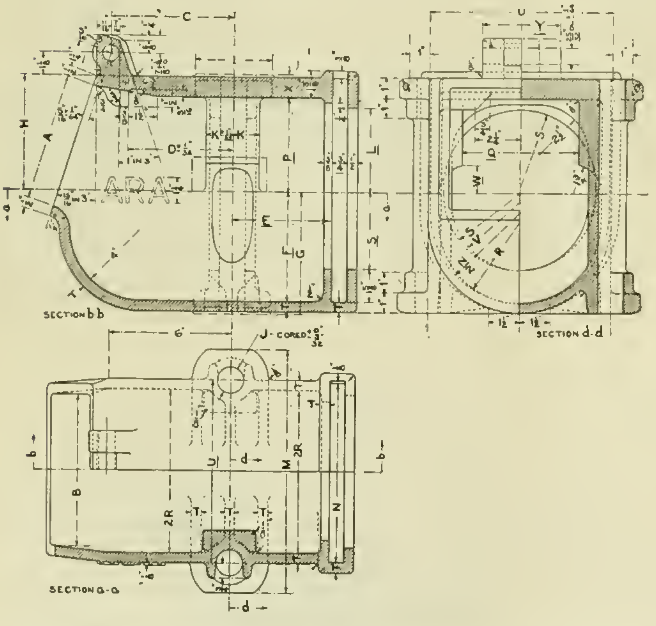
V AND V' MUST NOT DIFFER MORE THAN $\frac{1}{16}"$ ON ANY WEDGE.

Fig. 2—Wedge Gage



CLASSIFICATION OF GUARD	SIZE OF JOURNAL	A	B	C	D	E
C	5 X 9	8	9½	4⅝	6 3/16	4⅞
D	5½ X 10	8⅞	10	4⅞	6 11/16	5⅛
E	6 X 11	10⅝	10¾	5⅛	7 5/16	5⅝
F	6½ X 12	11	11⅝	5⅜	7 13/16	6¼

Fig. 3—Recommended Form of Dust Guard



Classification of Box.	Size of Journal.	A	B	C	D	E	F	G	H	I	J	K	L	M
C.	5 by 9	6¼	7¾	6 5/16	5 3/16	4⅞	5⅜	5⅞	5⅝	4¾	1¼	1 1/16	4⅛	12
D.	5½ by 10	6¼	7¾	6 9/16	5¾	5⅜	5⅝	6⅛	5⅞	5¾	1⅜	1 5/16	4⅜	12½
E.	6 by 11	7⅜	8¾	7 1/16	6¼	5⅞	5⅞	6½	6⅜	6¼	1½	1¾	4¾	14¼
F.	6½ by 12	8⅝	9¼	7 5/16	6¾	6⅜	6⅛	6⅝	.7	7¼	1⅝	1¾	5⅛	14¾

		N	O	P	Q	R	S	C.I. T	MC. S.C. T	U	V	W	X	Y
C.	5 by 9	8⅞	1½	4⅝	5¾	4	3¾	½	¼	9	3⅜	1⅜	1	3⅞
D.	5½ by 10.	9¾	2	4⅞	6¼	4	4	½	¼	9½	3 11/16	1½	1	3⅞
E.	6 by 11	11½	2½	5⅜	7¼	4⅝	4⅜	⅝	5/16	10½	4	1½	1⅛	4⅜
F.	6½ by 12	11¾	2½	6	7¾	5⅛	4⅝	...	⅜	11	4¼	1½	1⅛	4⅜

Fig. 4—Proposed Standard C, D, E and F Journal Boxes

Journal Boxes

To meet various suggestions for change, and to increase uniformity of standards, we submit Fig. 4, showing journal boxes C, D, E and F, recommending that they be substituted for the present standards.

The bottom of dust guard pocket has been made semicircular, to reduce the cost of box. The angle of lid face has been made the same for all boxes. Various minor, or unimportant, dimensions have been unified. No changes affecting interchangeability, or serviceability, have been made.

Springs

Complaints relating to the unsatisfactory results from standard springs have been increasing rapidly. The causes of the trouble, according to the analysis of your committee, are: (1) Unsatisfactory process of manufacture; (2) quality of material; (3) irregular surface of spring ends, and (4) improper application of shims under or over springs to raise the car body to normal height. The result is that many springs either break or take a permanent set.

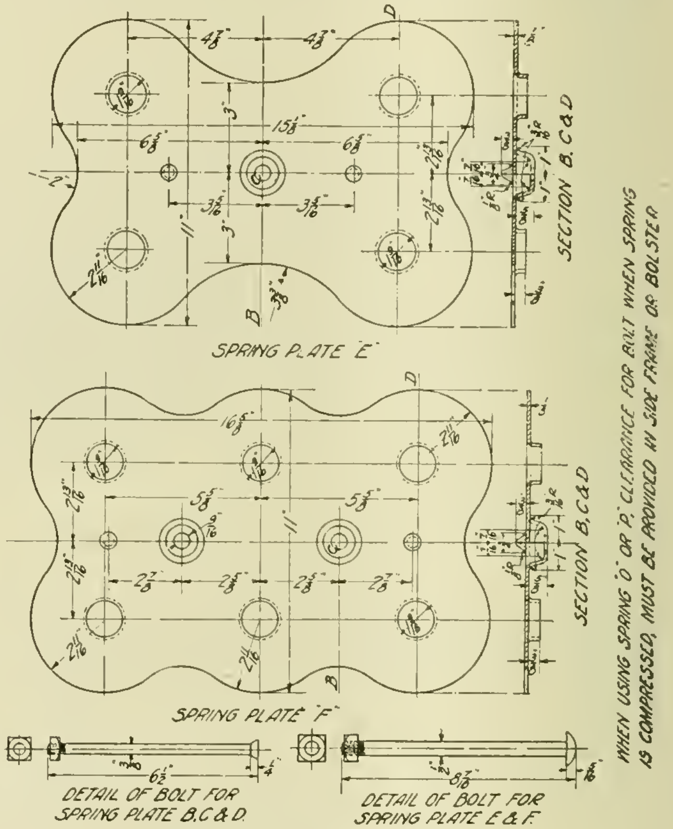


TABLE OF SPRING GROUPS

CLASS OF		Nº OF COILS		SPRING	HEIGHT INCLUDING PLATES		CAPACITY	
TRUCK	SPRING	Nº 1	Nº 2	PLATE	FREE	SOLID	SOLID	FOR H=7½"
2B	L	4	0	B	8½"	6½"	61900	30950
2C	M	4	2	C	8½"	6½"	70420	35210
2D	N	4	4	D	8½"	6½"	78940	39470
2E	O	5	5	E	8½"	6½"	98675	49338
2F	P	6	6	F	8½"	6½"	118410	59205

Fig. 5—Truck Spring Details

The remedy recommended is: (1) To improve the method of manufacture by better control of heating and tempering for more uniform results, and to obtain greater uniformity of coiling; (2) to use alloy steel; (3) to grind the ends of the springs to present a flat bearing surface of at least two-thirds the circumference at right angles to the axis of the spring; (4) to prescribe that shims, placed under or over the springs, shall consist of metal plates with parallel surfaces, and (5) to design the springs for a unit stress, when solid, of close to 100,000 lb. per sq. in., using the present diameters of bars, thereby materially increasing the capacity and range of deflection.

These changes should result in: (1) Material decrease in shock on side frames; (2) increased life of springs, and (3) decrease of maintenance cost and car delay.

It is recommended that the springs classified "L," "M," "N" and "O," as illustrated, in Figs. 5 and 6, be adopted as alternates for springs "B," "C," "D" and "H," and that alternate spring "P" be added for use with 2/F trucks.

The committee requests that railroads try out these springs thoroughly, in order to be in position later to vote on their adoption as standard. It is recommended that interchange rules be formulated to protect the alloy steel springs against being replaced with ordinary springs.

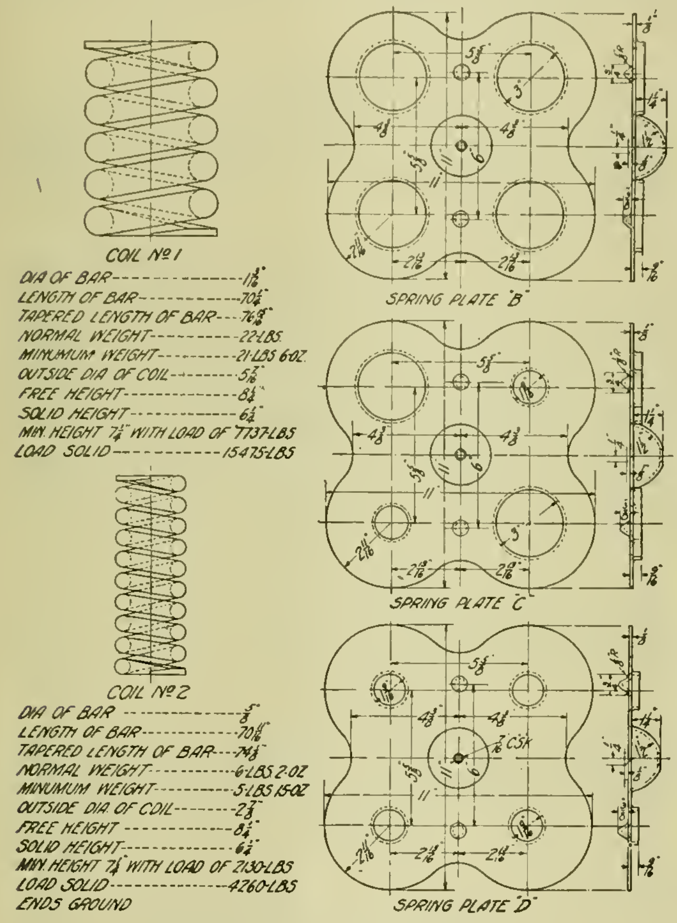


Fig. 6—Truck Spring Details

The secretary has referred this to the Committee on Specifications and Tests for Materials, requesting preparation of specifications.

Fundamentals

Inquiry relating to fundamentals, and their meaning, indicated the necessity of describing those pertaining to minimum areas more in detail. The minimum area between rear followers of the center sill construction is the whole area in compression under end force, without deducting for rivet and other holes, which are filled with metal.

In the formulæ on which former requirements were based, page 772, 1920 Proceedings, line "e," under heading "For center sills between rear followers," the word "tension" should have been omitted, making it read:

The minimum area = 2.5 T.

The tension and bearing area requirements, but not the shear area requirements, shall be governed by the value of the steel. For bearing area between surfaces of different grades of steel in contact, the value of the lesser grade of steel shall govern. For grade "A" steel, for which the product of elastic limit in pounds multiplied by the elongation in per cent is not less than 700,000, the areas given are required. For grade "B" steel, for which the designated product is not less than 850,000, the given areas may be reduced by 12½ per cent.

It was stated that the adopted height from rail to top of truck side bearings of 27⅝ in. would prevent the use of roller, ball or rocker side bearings. The dimension given refers only to flat truck side bearings.

The intent of the committee is to make designs that will establish fixed conditions, permitting the use of detail designs standardized by the Association, or the substitution of other parts preferred by the individual railroad, singly or in groups, provided these parts, or group of parts, are the equivalent in strength and safety of, and interchangeable with, the standard part or group of parts replaced. This will permit using any special detail such as top side bearing, which is interchangeable with, and equal in strength to, the side bearing that may be standard, or special top and bottom side bearings, which as a group are similarly interchangeable with the standard top and bottom side bearings as a group.

The standards should be made attractive for use by being as good or better than parts that may be substituted, rather than by making their use compulsory.

Truck Design

A subcommittee of the Committee on Car Construction, in co-operation with the Truck Committee of the Manufacturers Association, are engaged in the design of cast steel side frames and bolsters. They have considered the limits of dimensions fixed at the last meeting of the Mechanical Division and have given full consideration to the previously recognized dimensions of the M. C. B. Association, and to the designs that were put into effect by the United States Railroad Administration.

The manufacturers' committee has met with the subcommittee on two occasions, each time submitting for consideration designs in detail representing various ideas in view, but up to this time no single design has been brought out that could be presented as a recommendation for standard. It is possible that more than one design will have to be considered, with alternates.

Standard Car Design

Pending the development of complete A. R. A. car designs, freight cars according to the essential standards of the American Railway Association may be ordered from any car builder according to the following:

Type	U. S. Spec. No.
Single sheath box	1001
Steel box	1341
55-ton hopper	1005
70-ton hopper	1007
70-ton gondola	1755
50-ton gondola	1004
40-ton truck	1274
50-ton truck	1276
70-ton truck	1241

The height of center plates should be specified as 26¾ in., as more fully described in American Railway Association, Mechanical Division, Circular S III-189. This increased height of center plate introduces eccentricity as between the line of shock and the axis of the center sill sections, which changes the ratio of stress to end load, to offset which, it is necessary to add two bottom angles to the center sills if the sectional area of the center sill is desired to be 30 sq. in. This would add about 500 lb. to the weight.

The height of sides of car, A. R. A. standard, is 8 ft. 6 in.

minimum inside. In event cars are ordered to the height shown in the drawings (9 ft.) no change in drawings is entailed. For the minimum height of 8 ft. 6 in., dimensions affected by the height, including the dimensions of box car doors, must be changed accordingly.

The report was signed by W. F. Kiesel, Jr. (chairman), Pennsylvania System; A. R. Ayers, New York, Chicago & St. Louis; C. E. Fuller, Union Pacific; J. C. Fritts, Delaware, Lackawanna & Western; C. L. Meister, Atlantic Coast Line; J. McMullen, Erie; T. H. Goodnow, Chicago & North Western; John Purcell, Atchison, Topeka & Santa Fe; W. O. Moody, Illinois Central; J. A. Pilcher, Norfolk & Western; H. L. Ingersoll, New York Central; W. H. Wilson, Northern Pacific, and F. W. Mahl, Southern Pacific.

Report of Committee on Loading Rules

During the past year conferences were held with the steel shippers, and also with the stone shippers of the Bedford, Indiana, district to consider suggestions offered by them for changes in the existing rules.

Trial shipments of twin loads of structural steel over five feet in height and having the center binder omitted were sent out at request of the steel shippers to determine the necessity for center binders. The information obtained through these trial shipments was not conclusive and the trial has been further extended.

General Rules

The following detailed changes in the Loading Rules are submitted for approval:

RULE 5

Changed "80,000" to "60,000" in second and third paragraph. Revised table to show 95,000 lb. as total weight of car and lading for cars of 60,000 lb. marked capacity. *Explanation:* Rule changed to provide limits for 60,000 lb. capacity cars on basis of axle capacity, to conform with Interchange Rule 86.

RULE 23

Revised to read as follows: "If, in loading cars, it is impossible to clearly ascertain whether the restrictions given in General Instructions under paragraph 8 are complied with, the following table may be used." *Explanation:* Reference to General Rule 9 has been omitted, as this rule refers to twin or triple loads. Rule 23 and the accompanying table pertains to single loads only.

Table of weights revised. *Explanation:* Limits for 100,000 lb. capacity cars revised to make these limiting weights consistent for various lengths of cars. The word "average" added to heading of second column to clarify the meaning. Thirty and 32 ft. cars omitted from the table account of no longer being used. Thirty-six, 38 and 48 ft. cars added to the table to take care of existing cars.

Group I—Lumber, Logs, Etc.

RULE 101

Add the following sentence to end of the rule: "Lumber or timber less than 12 ft. in length should not be loaded on flat cars or above the sides or ends of gondola cars."

Group II—Structural Material, Castings, Etc.

RULE 201

Omit last sentence from the rule, to clarify the meaning.

RULE 202

Fourth sentence of third paragraph revised to read as follows: "Short material may be loaded on car floor, if equally distributed over entire floor; total weight of entire lading must not exceed the load weight as per General Rule 5." *Explanation:* Reference to "capacity" changed to "load weight" to conform with reference to "load weight" in third sentence of third paragraph.

RULE 213

Third sentence of rule changed to read as follows: "The blocking should never consist of less than one 3-in. plank set on edge, or its equivalent, and must be secured from shifting by cleats nailed or bolted to the floor." *Explanation:* Revised to omit requirement for more than one plank for end protection.

RULE 217

First paragraph of rule changed to read: "When the lading consists of very flexible material, such as plates, no bearing-piece is required on the floor of the car, but blocking as prescribed by Rule 213 must be used to protect the end boards." *Explanation:* Revised to conform with Rule 213 for end protection.

RULE 227

Revised to read: "Material loaded on gondola cars with drop ends or on flat cars, as shown in Figs. 62 and 63, must have one hardwood bearing-piece not less than 10 in. by 10 in. for loads up to 65,000 lb. per bearing-piece, and not less than 12 in. by 12 in. for loads exceeding 65,000 lb. per bearing-piece. (See General Rule 31-A for light loads.)" *Explanation:* Requirement for 7/8-in. bolts to secure bearing-pieces has been omitted. Bearing-pieces are secured by 1 1/4-in. rods passing through bearing-piece and floor of car.

RULE 250

Second paragraph changed to read: "Wrought iron pipe should not be loaded inside of larger sizes of pipe unless below the ends or end gates of car."

RULE 260

Insert words "or gondola" after the word "flat" in marginal reference of rule. Insert words "or gondola" after word "flat" in first line of first paragraph.

RULE 265

Revised as follows and drawings changed to accord therewith:

"Metal sheets loaded in box cars should be secured in accordance with Figs. 90, 90-A, 91 and 92. Sheets in each pile should be preferably of uniform size and there must be at least two 2 in. by 4 in. uprights secured to inside of car at the end of each pile to provide a uniform bearing surface and to prevent the sheets from cutting through the end lining of car; also upright strips not over one inch thick should be used between the lading and sides of the car.

"The piles must be securely wedged apart at least at two points by braces consisting of 2-in. by 4-in. uprights against the piles, securely wedged apart at top and bottom by 2-in. by 4-in. pieces, as per Figs. 90, 90-A and 91. Each upright piece to be secured by two 2-in. by 4-in. cleats nailed to floor to prevent shifting, and tied together at top by not less than 1-in. by 4-in. longitudinal strips to prevent shifting.

"The bracing at ends of piles toward center of car shall consist of one upright piece 2 in. by 4 in. against end of pile, backed up by one upright piece 2 in. by 8 in. against side of car, both to extend full height of load and be securely nailed to side of car as per Fig. 90; and, in addition, there must be one piece of 2 in. by 4 in. extending across doorway at top of load, securely wedged against bracing of load in opposite end of car, also one piece of 2 in. by 4 in. extending from upright at end of pile to doorway and securely nailed to side posts and braces as per Fig. 90.

"Where height of load exceeds 30 in. it will be necessary to apply additional longitudinal bracing at center of load.

"Uprights to be secured at bottom by two 2-in. by 4-in. pieces extending to doorway, and one piece of 2 in. by 4 in. extending full width of pile, securely nailed to floor as per Fig. 90.

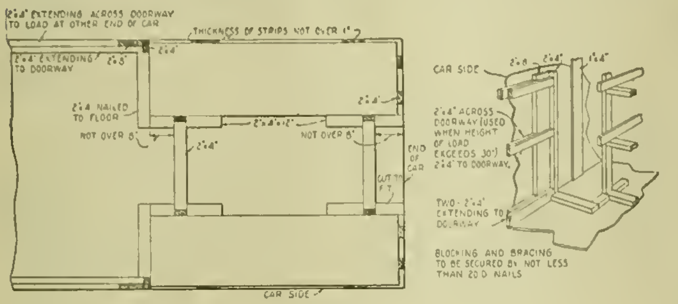


Fig. 90

"Wedges at bottom of load are optional; if used, they should conform to Fig. 91, and where width of pile exceeds 28 in. three wedges should be used.

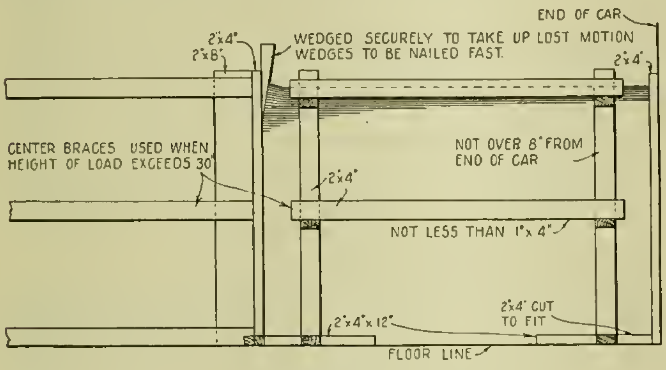


Fig. 90-A

"In all cases, where there is space between ends of sheets and uprights at top of pile, wedges must be used as per Fig. 90-A.

"When oiled sheets are loaded they should be placed on suitable strips and heavy paper used to prevent oil stains on the floor of car.

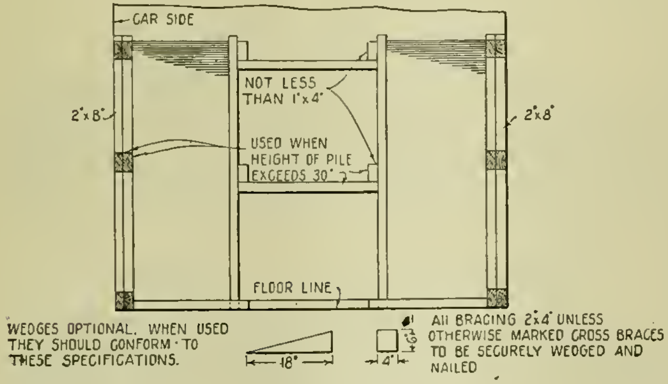


Fig. 91

"There may be more than one pile of sheets in each corner of car, provided there are at least two 2-in. by 4-in. pieces between ends of piles, secured in an upright position and extending from car floor to at least 2 in. above top of pile and each pile is braced against side of car.

"Bundled metal sheets loaded in box cars should be loaded in accordance with Fig. 92. After piling of sheets is completed, the center of pile should be compressed solid and top cross-piece *X* must be nailed and cleated to car sides. This cross-piece must also be further secured by having a 2 in. by 4 in. placed against side of pile and nailed to floor of car and top of cross-piece.

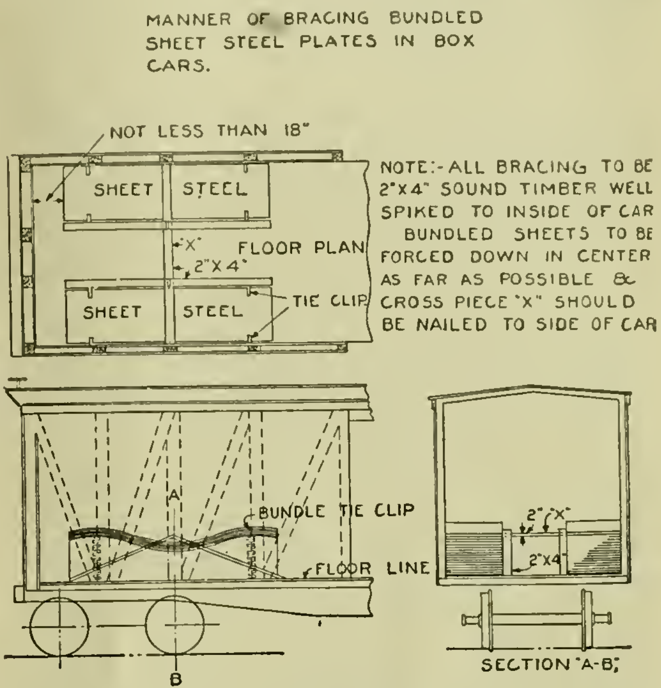


Fig. 92

"All blocking and bracing to be secured by not less than 20-penny nails."

Explanation: Rule and figures revised in conference with shippers to furnish more substantial blocking and bracing for this class of material, to better protect both lading and car.

Group IV—Concrete Culvert Pipe, Brick, Stone, Etc.

The following revisions of the stone loading rules are recommended as the result of conference with the shippers of stone:

Rule 401

Second paragraph revised to read as follows: "Where separating strips to keep lading clear of car floor are referred to in these rules, they should be sound wood, not less than 3 in. wide by 1½ in. thick. Such strips shall extend full width of stone and be placed approximately one-fifth the length of stone from each end. Where more than one strip is used to make the required thickness, the strips should be securely nailed together. In no case is it considered good practice to use more than two bearing-strips per length of stone. Stone longer than 10 ft. should, whenever practicable, be loaded over trucks." *Explanation:* Revised to include increase in size of separating strips; definite location for strips; strips to be nailed together where necessary; not more than two strips per stone; stone over 10 ft. long to be loaded over trucks; sound wood specified in place of soft wood.

Rule 405

First paragraph: Insert the following at end of second sentence: "See Rule No. 401 for minimum size of wood strips."

Rule 405

Insert the following paragraphs after second paragraph of rule:

"Where practical, the following method of loading should be used for flagging, slabs or stone sawed on two sides.

"Slabs 2½ in. thick and less, shipped in quantities, to be loaded on edge, lengthwise of car. Where a few pieces only of this group of sizes goes on a car, such few pieces may be loaded flat on top of slabs not less than 4 in., but not more than four pieces in any one stack.

"Three-inch slabs shipped in quantities loaded flat should have a slab not less than 4 in. under each pile. There should be no more than eight 3-in. slabs in any one pile, either loaded on a 4-in. slab, or on the floor of a car. Three inch slabs longer than nine ft. must be loaded on edge or flat on a slab not less than 4 in. in thickness or not more than two on top of any shorter stack.

"Four-inch slabs shipped in quantities loaded flat on car to be loaded not more than eight slabs high. Where 4-in. slabs are loaded on slabs 5 in. thick or over, then the same amount may apply on slab as flat on car. Four-inch slabs longer than 10 ft. should, wherever possible, be loaded on slabs thicker than 4 in.

"Five-inch slabs shipped in quantities loaded flat on car to be loaded not more than eight slabs high. Where 5-in. slabs are loaded on slab 6 in. or over, then the same amount may apply on slabs as flat on car. Five-inch slabs longer than 11 ft. should, wherever practicable, be loaded on slabs thicker than 5 in."

Explanation: To provide definite rules for piling slab stone.

Rule 405

Third paragraph, second sentence, revised to read: "If necessary, to prevent stone from shifting past the end stakes, a standard board should be securely nailed to the inside of the end stakes and extend full width of stone." *Explanation:* Revised to indicate when board protection is required.

Rule 408

Marginal reference revised to include "stone sawed on more than two sides." First sentence of first paragraph revised to read: "Curbing and stone sawed on more than two sides when loaded lengthwise of car should have two standard stakes opposite each outside piece." *Explanation:* Rule revised to include stone sawed on more than two sides.

Rule 409

Second paragraph, second line, word "soft" changed to "sound." *Explanation:* To permit use of various woods that may be available.

Rule 410

The first paragraph revised to read as follows: "Mill block loaded lengthwise or obliquely on car should be protected on the sides and ends by cleats not less than 2 in. by 4 in., in section, extending at least three-fourths of length or width of stone or by not less than two wedges 3 in. by 3 in. on sides and 4 in. by 4 in. on ends, wedges to be not less than 14 in. long and securely nailed to floor of car at right angles to stone. When the width of stone exceeds 3 ft. 6 in., or length of stone exceeds 10 ft., the side and end protection must consist of not less than three wedges. If stone is loaded crosswise of car and width of stone does not exceed 3 ft., only one wedge will be required for side protection. All side and end cleats of wedges must be sound, straight grained lumber secured to floor of car by not less than 40-penny nails. When the stone is loaded close together or wedged apart, cleats or wedges are required on sides and ends of outside stone only. When such stone is loaded in tiers, standard end and side protection must be provided." *Explanation:* Reference to height of stone omitted. Provision included for use of wedges in place of cleats. Sound lumber secured by not less than 40-penny nails is specified for cleats and wedges.

Second paragraph revised to read: "Mill block containing as much as 100 cu. ft. resting on channel or scabbled surface not less than 25 sq. ft. or proportional for increased sizes must be so loaded that the weight of total lading will be uniformly distributed over the floor of the car." *Explanation:* Requirement of a layer of sand, cinders or crushed stone for supporting the stone has been omitted. Not essential for uniform bearing.

Third paragraph revised to read: "Gondola cars are preferable for such shipments, but if flat cars are used, the lading should be placed at least 18 in. back of end of car. When car is equipped with end stake pockets and stone is loaded closer than 18 in. to end, standard stakes 6 in. high should be used. When the stone does not engage both stakes, wedges in addition to stakes must be used. Each block of stone loaded lengthwise, crosswise or obliquely must be protected against creeping as specified in first paragraph of this rule. When two blocks of stone are loaded parallel and close to each other, or wedged apart, they will be considered as one stone as to cleating or wedging." *Explanation:* Provision made for end stake blocking where car is equipped with end stake pockets and stone is loaded closer than 18 in. from end.

Fourth paragraph revised to read: "If stone is placed lengthwise of car and is 4 in. or closer to side of car, two standard side stakes 6 in. in height must be placed opposite such stone in lieu of cleats or wedges on that side of stone. Stone must not be loaded obliquely when it is possible to load it lengthwise or crosswise of car." *Explanation:* Reference made to wedges to conform with change in first paragraph of rule.

Fifth paragraph omitted from rule. *Explanation:* Covered by first paragraph of revised rule.

Sixth paragraph: The following words, "when used," inserted after the word "cleat" in first line. *Explanation:* To conform with first paragraph of rule.

New paragraph added as follows: "In no case shall the height of stone be more than two times the smallest dimension resting on the car floor." *Explanation:* This paragraph establishes a limit for the height of stone in proportion to the base in accordance with the practice which is generally followed in loading large stone.

Rule 411

First paragraph, second sentence: Change the words "one and one-half" to "two." *Explanation:* To conform with first paragraph of Rule 410.

Group V—Automobile Loading

Rule 518

Rule revised to read: "The distance between any two vehicles, at the nearest point, loaded on a freight car must not be less than the following limits: 2 in. horizontally, 3 in. vertically with springs compressed and 4 in. vertically without springs compressed." *Explanation:* Revised to permit a 3 in. vertical clearance where cars are shipped with springs compressed.

End Stake Pockets for Flat Cars

In conference with stone shippers, the sub-committee of the Loading Rules Committee agreed to recommend to the Committee on Car Construction that end stake pockets be required on future flat cars. This subject is, accordingly, hereby referred to that committee.

The report is signed by R. L. Kleine (chairman), Pennsylvania System; J. J. Burch, Norfolk & Western; E. J. Robertson, Soo Line; J. E. Mehan, Chicago, Milwaukee & St. Paul; Samuel Lynn, Pittsburgh & Lake Erie; Ira Everett, Lehigh Valley; T. O. Sechrist, Louisville & Nashville; E. N. Harding, Illinois Central, and G. R. Lovejoy, Detroit Terminal.

Brake Shoe and Brake Beam Equipment

The 1920 Brake Shoe and Brake Beam Committee in its report presented at the last annual meeting engaged for the 1921 committee to give attention to eight subjects. These subjects have been given careful consideration and are hereinafter reported on as follows:

Gage for Determining Hanging Heights of Existing Beams

The value of such a gage is insufficient to warrant the expense incident to its development and manufacture for general distribution. The old types of cars on which wide variations of hanging heights exist and which prompted the idea of such a gage are gradually being eliminated. There is an increasing demand and tendency to standardize brake beams and hangings, which will eliminate the necessity for such a gage.

Code Governing Brake Beam Maintenance Practices

The committee recommends as the first progressive step the early adoption of a standard practice covering the reclamation of brake beams in such a manner that they will meet the standard specifications used in the purchase of new brake beams.

A sub-committee was appointed to submit a tentative standard practice and has submitted one which is deserving of the careful consideration of the association. It is submitted as a progress report and it is recommended that the report be submitted to the members of the association with the request that each submit his criticism to the committee to assist it in the final development of a standard practice that will satisfactorily meet the requirements. See Exhibit A.

Advisability of Brake Head Strength Test

This subject was referred to a sub-committee of engineers of tests which conducted some laboratory tests on 21 different types and capacities of brake beams representing the products of seven different manufacturers, at the Collinwood laboratory of the New York Central Lines, and submitted the report which is incorporated herein as a progress report. The conclusions reached by the sub-committee read in part as follows:

> Tests of brake-beam heads do not appear necessary if the load in service always comes upon the center lugs. However, if in the opinion of the Brake Beam Committee, the load is not always restricted to the center lugs, but is frequently carried principally on the toes, then a standard strength of head, and standard method of test for determining same, is desirable.

The committee believes that all of the stress on brake heads is frequently sustained by the top and bottom lugs and that brake head strength tests are a proper and reasonable requirement and should eventually be incorporated in the specifications. Accurate and practical methods of making such tests are, however, still obscure and will require further careful study and investigation by the committee. See Exhibit B.

Increasing the Initial Brake Shoe Thickness

In view of the adoption as standards of the association, of brake heads of the A, B and C depths last year to take care of existing brake beam clearance conditions, the committee deems it advisable that no changes be made in the standard brake shoe thickness of 1½ in. at this time.

Details of Top and Bottom Head Lugs

This subject refers to the recesses in the top and bottom brake head lugs which receive the top and bottom brake shoe lugs. The standard drawing does not show all of the dimensions and manufacturers were conferred with to determine the practice. It was found that the depth of the recesses is uniformly 1¼ in. from 17¾ in. radial line; the width at the opening is in practically all cases 1⅝ in. and at the bottom varies from 1⅛ in. in the majority of cases to 1 7/16 in.

The committee recommends that Section CC, Sheet M. C. B. 17, be revised to show the dimension 1⅛ in. as the width of the bottom of the recesses adjacent to the top and bottom brake head lugs.

Brake Shoe Key Design and Fit of Shoes, Head Face and Key

This subject was referred to a sub-committee for investigation and its report is submitted as a progress report. The investigation will be continued by the committee. See Exhibit C.

General Brake Beam Hanging

This subject was referred to a sub-committee for investigation and its report was forwarded to the Committee on Car Construction which has the matter under consideration in connection with standard truck design.

Reversible Strut

This subject is still under consideration and the committee has nothing to report at this time.

Standard Depth of Brake Head

Last year there were adopted as standards three depths of brake heads designated as "A," "B" and "C" to meet clearance conditions obtaining on various cars. The committee recommends that heads "B" and "C" be removed from the standards and their use be permitted as alternates where the standard "A" head cannot be applied.

Status of the No. 2 and No. 2 Plus Standard Brake Beam

The status of the No. 2 and No. 2 plus standard brake beams, as regards the weights of cars to which each should be applied, has received special consideration at different times during the year.

The Train Brake and Signal Committee and the Brake Shoe and Brake Beam Equipment Committee were requested by the Car Construction Committee to submit their joint recommendations on this subject. The joint meeting of the two committees referred to was held at New York on April 5, 1921, and the following motion was carried by a majority but not a unanimous vote:

> The Brake Shoe and Brake Beam Equipment and the Train Brake and Signal Equipment Committees have considered the matter of No. 2 and No. 2 plus brake beams and recommended that these beams be used on cars of the following weights for four-wheel trucks:

BRAKE BEAM	CAR WEIGHT
2	35,000 to 48,000 lb.
2 plus	48,000 to 58,000 lb.
3	Over 58,000 lb.

In the case of six-wheel trucks, the above weights should be increased 50 per cent for the beams specified.

Report of this action was submitted to the Car Construction Committee.

Formula for Brake Power on Freight Cars

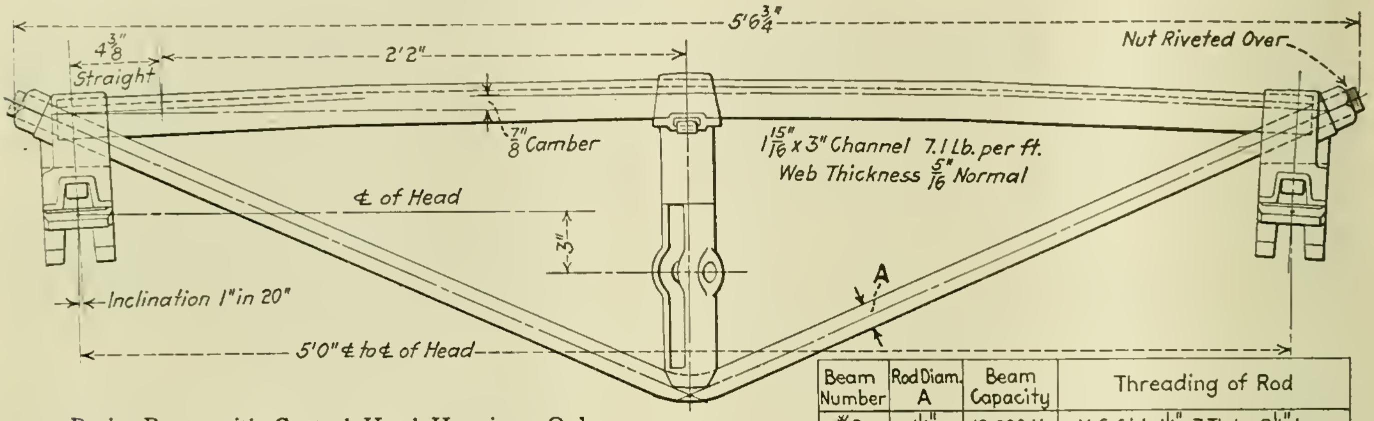
The Car Construction Committee in its last year's report recommended a new formula for brake power on freight cars.

The association requested the Train Brake and Signal Equipment and the Brake Shoe and Brake Beam Equipment Committees to submit joint recommendations on this subject. The joint meeting was held November 18, 1920, and a proposal to change the brake ratio as suggested was unanimously disapproved. An abstract of the report submitted to the Car Construction Committee follows:

> The purpose of the proposed change in braking power is to

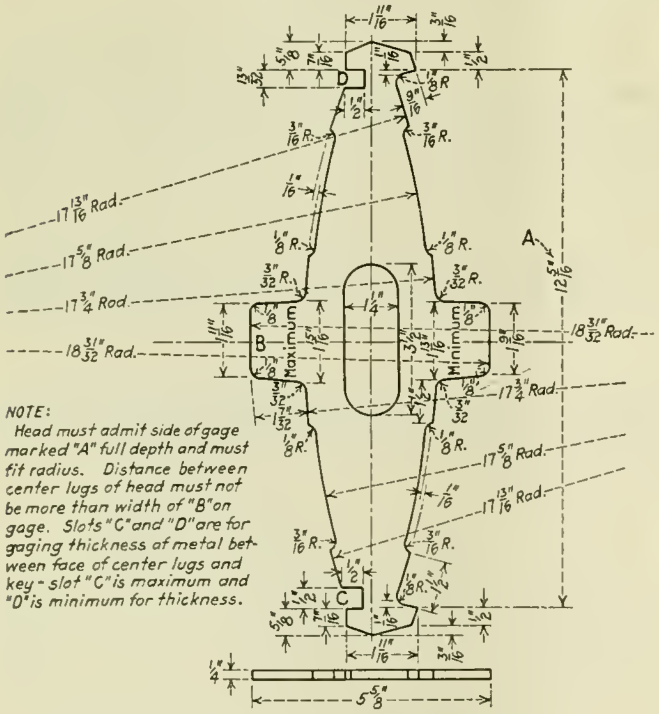
make the percentage of braking power more uniform on partially loaded cars in which there is a wide range in the ratio of light weight to loaded weight. While the proposed change will accomplish in a small measure the object sought, it will do so only by sacrificing the uniformity of braking power on empty cars. As the factor of retardation is highest when the cars are empty, it is essential that uniform braking power be maintained for empty cars.

The adoption of the proposed braking power formula will result in increasing the percentage of braking power on high capacity cars, to a point in excess of the capacity of standard 10-in. freight brake equipment, and for comparatively low capacity tank cars the application of the formula in some cases will reduce the effectiveness of the hand brake. It also provides for a lower percentage of braking power on refrigerator cars weighing approximately 55,000 lb. and having 5 in. by 9 in. journals. Because of the relatively high speed at which these cars are handled and the character of their lading, a reduction in braking power is not considered desirable, especially in view of the fact that they are handled in short trains in which a high percentage of breaking power is less objectionable than in the case of long trains.



Brake Beam with Central Head Hangings Only

Beam Number	Rod Diam. A	Beam Capacity	Threading of Rod
*2	1⅛"	12,000 Lb.	U.S. Std. 1⅛", 7 Thds. 2½" Long
*2+	1¼"	15,000 Lb.	U.S. Std. 1¼", 7 Thds. 2½" Long



NOTE: Head must admit side of gage marked "A" full depth and must fit radius. Distance between center lugs of head must not be more than width of "B" on gage. Slots "C" and "D" are for gaging thickness of metal between face of center lugs and key-slot "C" is maximum and "D" is minimum for thickness.

Fig. 1—Brakehead Gage

Standardization of Brake Beams Having Central Head Hangings

A start should be made to standardize brake beams having central head hangings only and having a maximum depth of brake head of 6½ in. and a maximum depth of brake beam of 7⅜ in. The committee submits to the association as recommended practice the accompanying drawing showing such a beam of the No. 2 and No. 2 plus capacity.

The report is signed by W. J. Bohan, Northern Pacific; C. B. Young, Chicago, Burlington and Quincy; F. M. Waring, Pennsylvania System; M. H. Haig, Atchison, Topeka & Santa Fe; H. W. Coddington, Norfolk & Western; G. E. Smart, Canadian National, and T. L. Burton, New York Central.

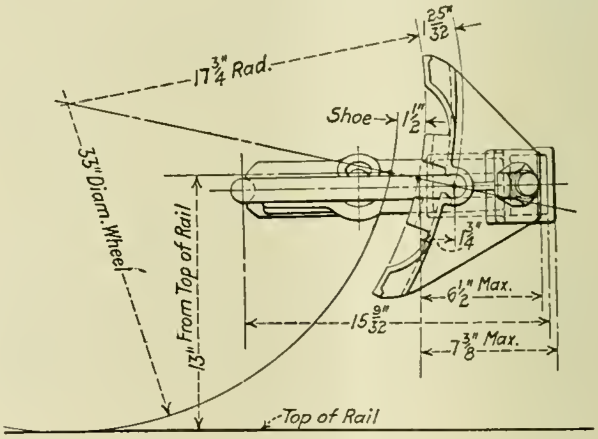


Exhibit A—Recommended Prctices on Brake Brake Beam Reclamation and Repairs

The reclaiming and repairing of brake beams should be centralized at some convenient place, where there is suitable equipment for doing the work in an economical and safe manner.

General Inspection

All defective brake beams that are received at a reclaiming plant should be completely dismantled. After brake beam has been dismantled the various parts should be separated and given a general inspection. Any part of the brake beam that has any of the following defects should be scrapped: Excessive deterioration due to rusting or long life; undue wear; broken or cracked.

The following practices should not be permitted: Building up any part of the brake beam by gas or electric welding; straightening of the strut or brake head by excessive heating; any parts of brake head or strut that cannot be straightened by heating slightly should be scrapped. It is desirable to straighten struts or brake heads cold.

Detail Inspection

The various parts should be very carefully inspected in the following manner:

Brake Heads.—All heads should be gaged with A. R. A. gage shown in Fig. 1. If the center lugs are worn sufficiently to take maximum center lug *B*, or if the thickness of metal between face of center lugs and part of key slots has worn sufficiently to take the minimum gage slot *D*, or if the toes are badly worn, the brake head should be scrapped. Brake heads with slightly worn toes can be used again. Brake heads should be free of burrs, core sand, dirt or any other foreign matter.

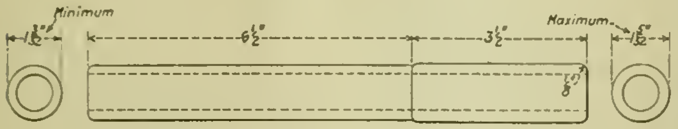


Fig. 2—Lever Pin Hole Gage

Struts—All struts should be gaged with lever pin hole gage shown in Fig. 2, and if hole is badly worn so it will take the maximum end of gage it should be scrapped. Any strut having lever slot walls twisted or badly worn should be scrapped. Struts having slots set on an angle should be gaged with angle gages similar to Fig. 3.

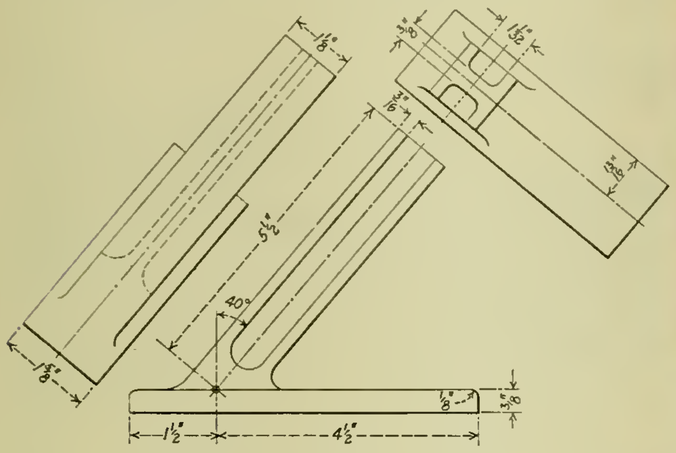


Fig. 3—Angle Gage for Strut

Any strut not bearing the proper capacity of the beam it is to fit should be so marked.

Tension Rods—Any tension rod that has been flange cut, badly rusted or threads badly damaged should be scrapped. Tension rods badly bent and twisted can be straightened by heating over their entire length.

Compression Member—Any compression member that has badly worn places due to release spring or any other cause should be scrapped. Compression members badly bent or twisted should be heated uniformly throughout and then straightened. If they are only slightly bent or twisted they can be straightened without heating. All compression members should be straight before reapplying.

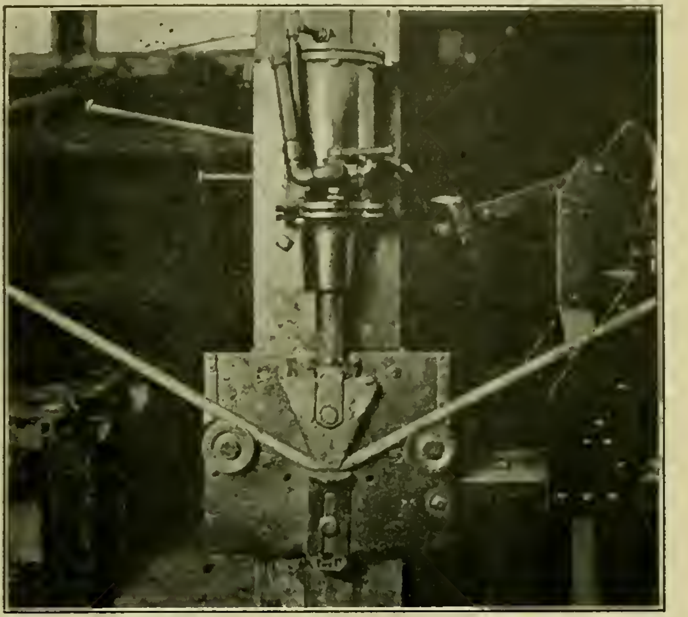


Fig. 4—Tension Rod Bending Machine

Equipment

The following equipment is recommended for use in connection with reclaiming brake beams:

Tension rod bending machine. Fig. 4 shows an air operated machine of this kind.

Assembling benches. Fig. 5 shows a bench of this kind now in use.

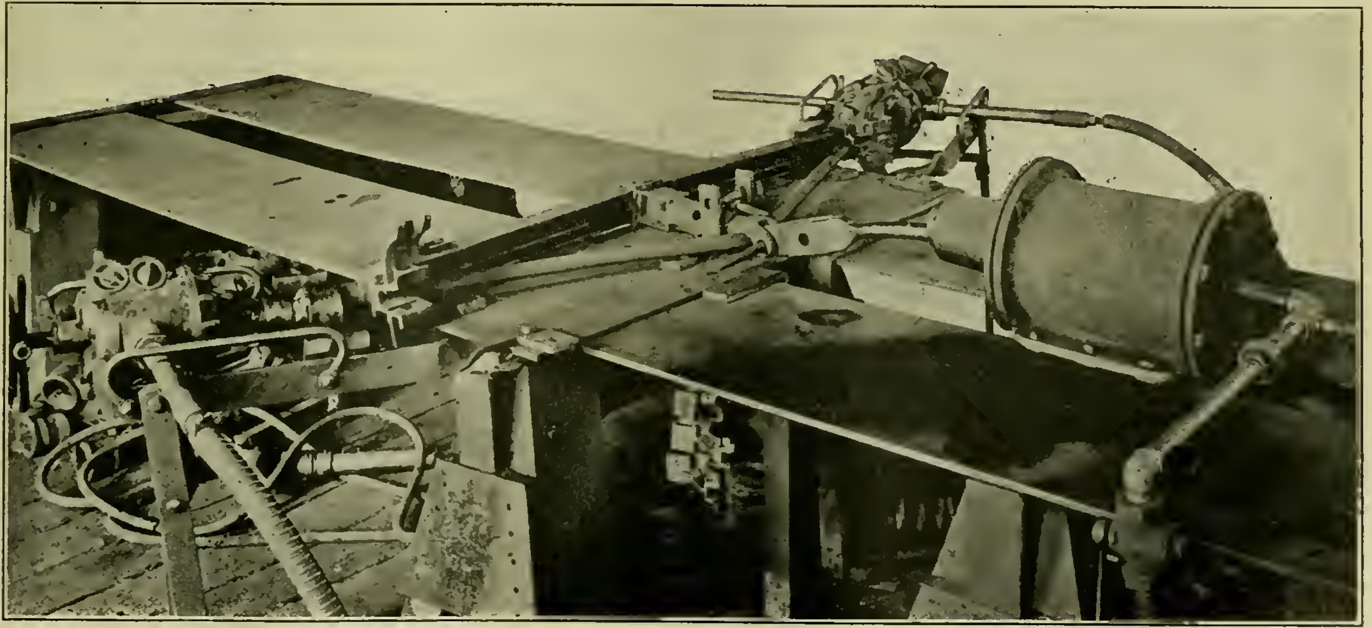


Fig. 5—Assembling Rack

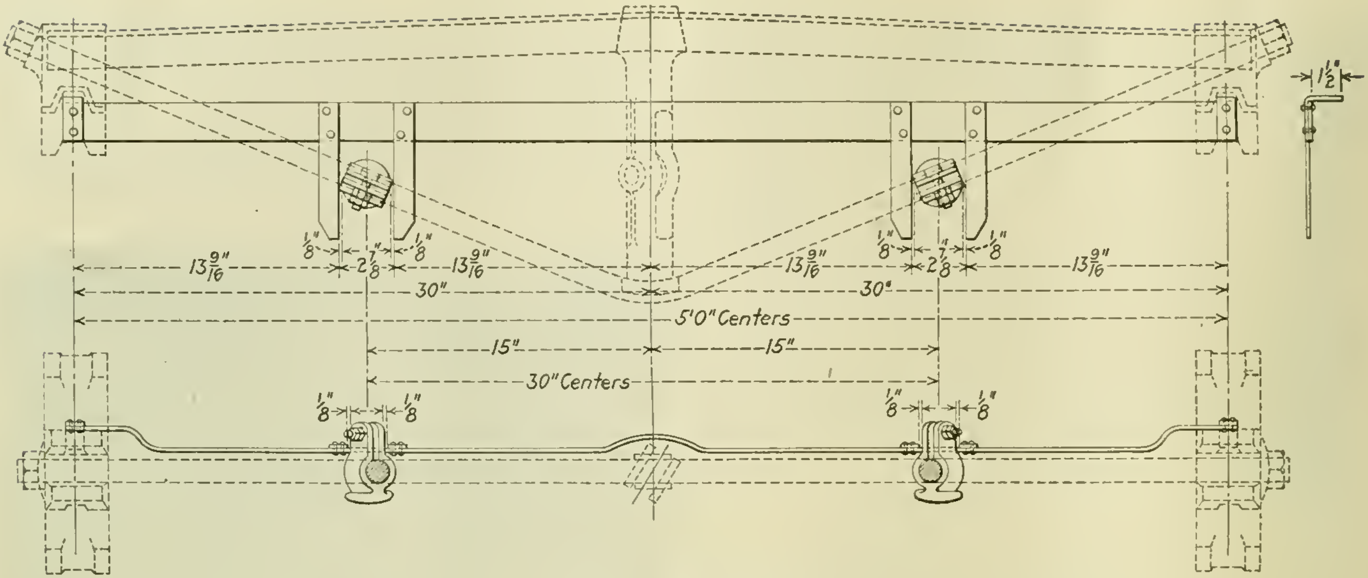


Fig. 6—Support Gage

Testing machine. Fig. 7 shows a 50,000-lb. testing machine and Fig. 8 a 75,000-lb. machine.

Suitable bins and racks for storing and caring for repair parts.

Air motor for applying nuts to ends of compression rods. Fig. 5 shows one of these motors in use.

Annealing oven.

Miscellaneous. Hammers, wrenches, etc.

Assembling and Testing

Strut should be applied to compression member and properly keyed in place.

Safety clips should then be applied.

If additional support chairs are used they should be applied next, fastening them in proper place, using a gage similar to Fig. 6.

Heads or sleeves should be placed on one end of the com-

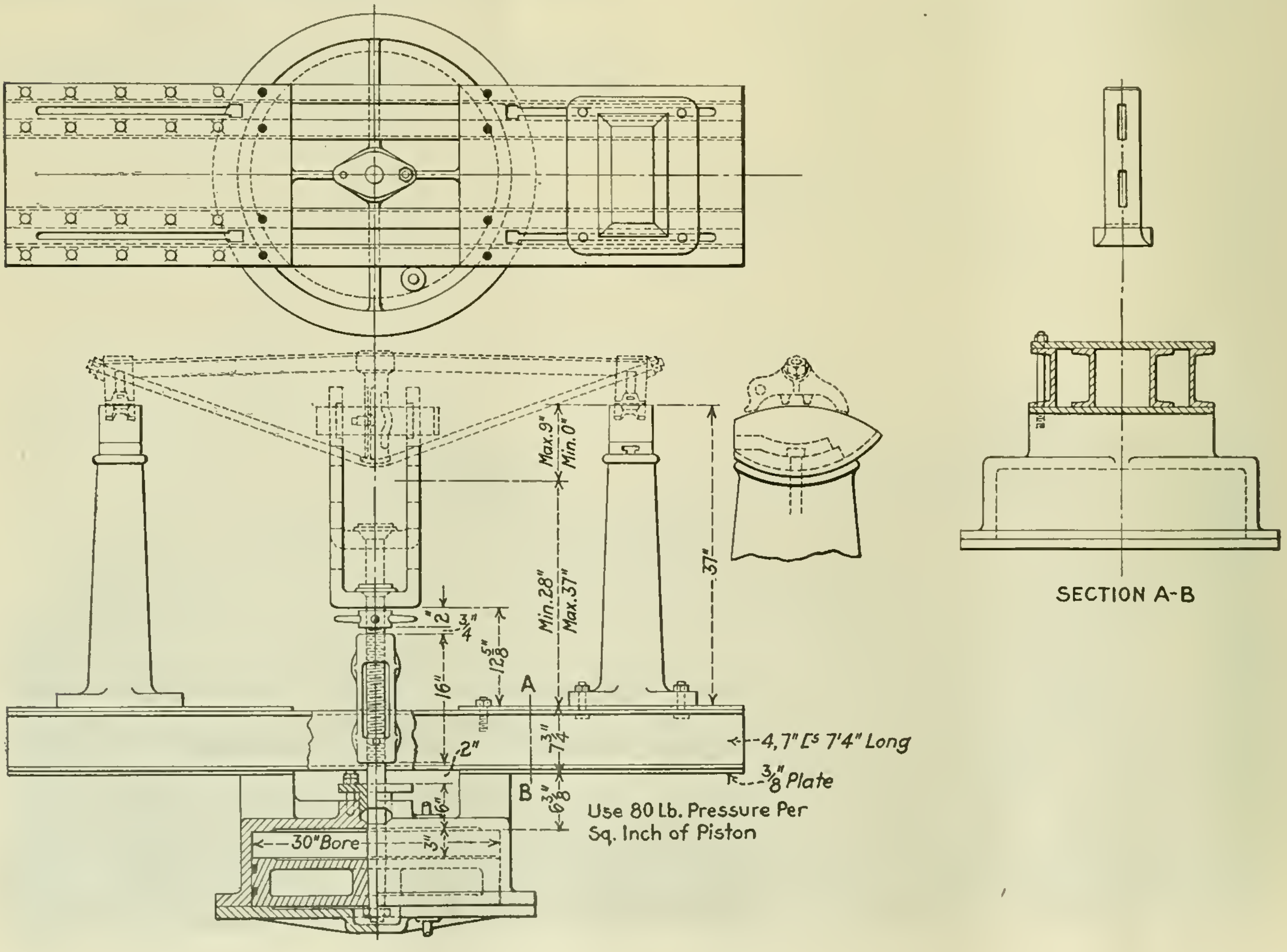


Fig. 7—Brake Beam Testing Machine, 50,000 lb. Capacity

pression member, making sure that the top is on the same side of the compression member as the head of the strut key. Some brake heads are right and left and care should be taken to see that they are properly mated. The tension rod should be inserted in the head or sleeve on the compression member, laying the truss rod seat in the end of the strut, and then apply the other head or sleeve.

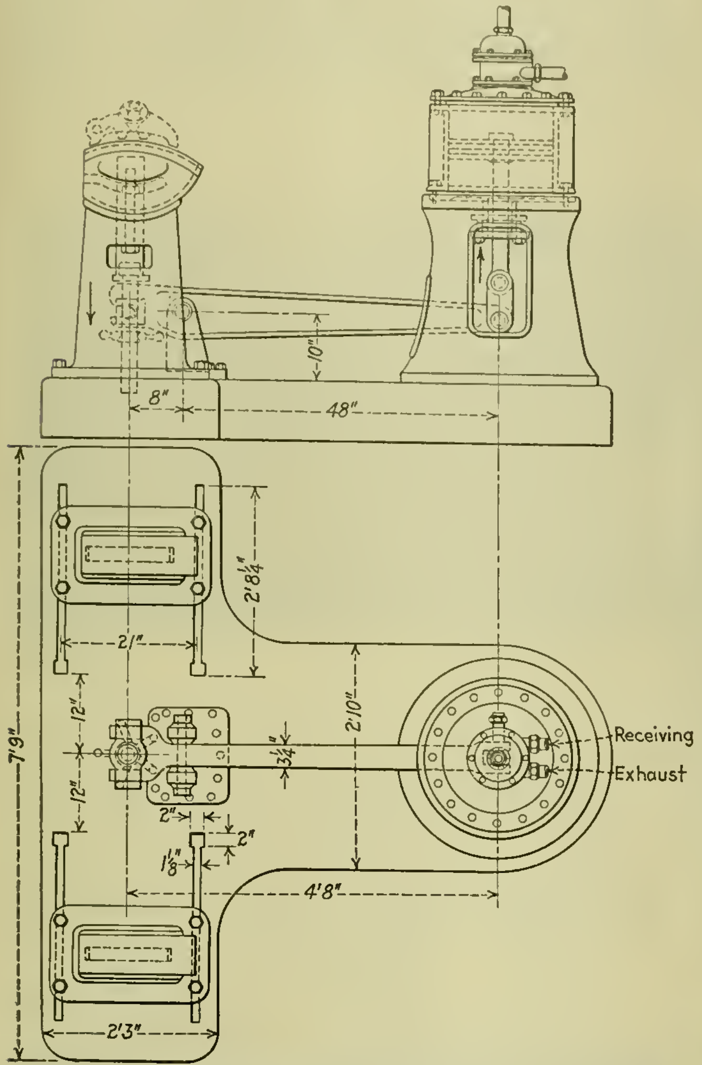


Fig. 8—Brake Beam Testing Machine, 75,000 lb. Capacity

Nuts should be applied to the ends of the tension rods, screwing them up to a full thread. This places the beam in tension or camber. The beam should be checked for correct camber, using a gage similar to Fig. 9.

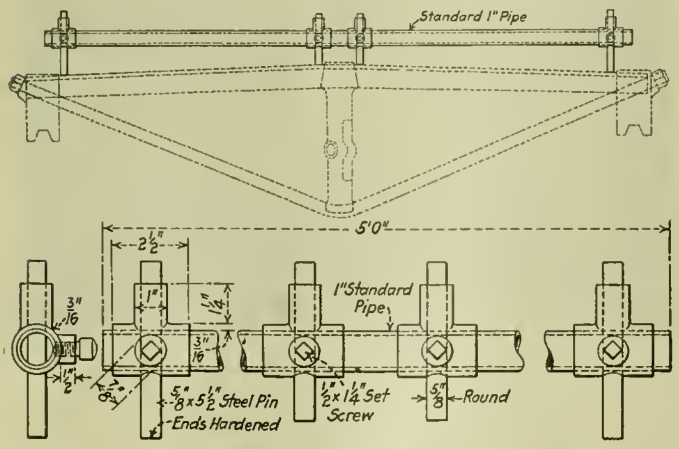
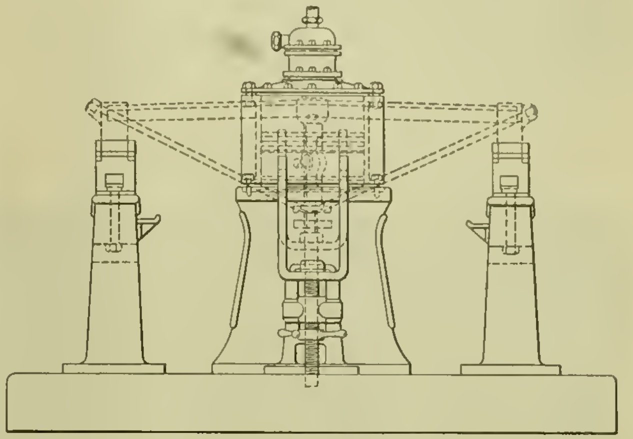


Fig. 9—Camber Gage

The beam should be placed in a proof testing machine similar to that shown in Figs. 7 or 8 and apply a proof load of the capacity of the beam, check and adjust the camber. After this a second proof load is to be applied, released, and the camber again checked. The truss rod nuts are adjusted until all four points of the camber gage come in contact with the back of the compression member. The ends of nuts are then riveted over about one-third of the rod circumference.



The beam should be checked for head centers with a gage similar to that shown in Fig. 10, by placing the legs of the gage in the top of the brake shoe key slot opening on the upper center head lug. If the gage goes in, the beam will meet A. R. A. head center requirements. The pin hole location should be checked with a gage similar to that shown in Fig. 11. Beams having rigid heads must be carefully checked to see that both heads are parallel. Fig. 12 shows a device for straightening these heads.

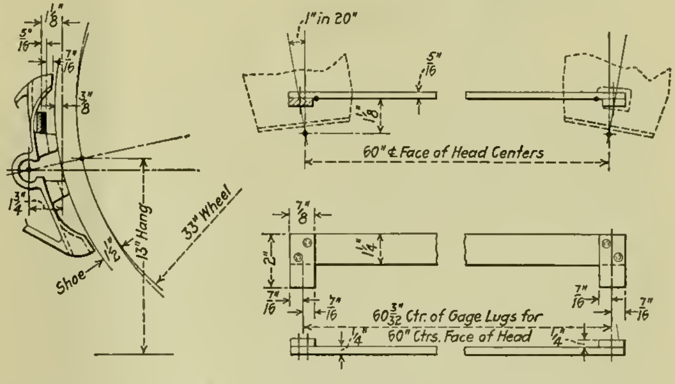


Fig. 10—Head Center Gage

All beams should be well covered with quick drying metal paint.

Exhibit B—Brake Beam Head Strength Tests

No. 2, No. 2 plus and No. 3 brake beams complete with brake heads, were furnished by seven manufacturers for test purposes, a number of different styles of brake heads being represented. Tests of the brake heads of these brake beams were made in all cases by applying the load to the strut of the brake beam as under service conditions. The three conditions under which the load might come upon the brake head were considered: (1) center lugs only resting upon the support, (2) brake head cocked, so that one center lug and one toe rested upon the support, and (3) toes resting upon the support, with center lugs free.

The test results obtained under condition (1) evidenced no set and but slight deflection at the set load called for by the brake beam. Tests under condition (2) were found to be impracticable. It was therefore concluded that test under condition (3) represented the maximum condition of weakness, and this method of supporting the brake head for test was accordingly chosen as adequately covering any possible condition that might be obtained in service.

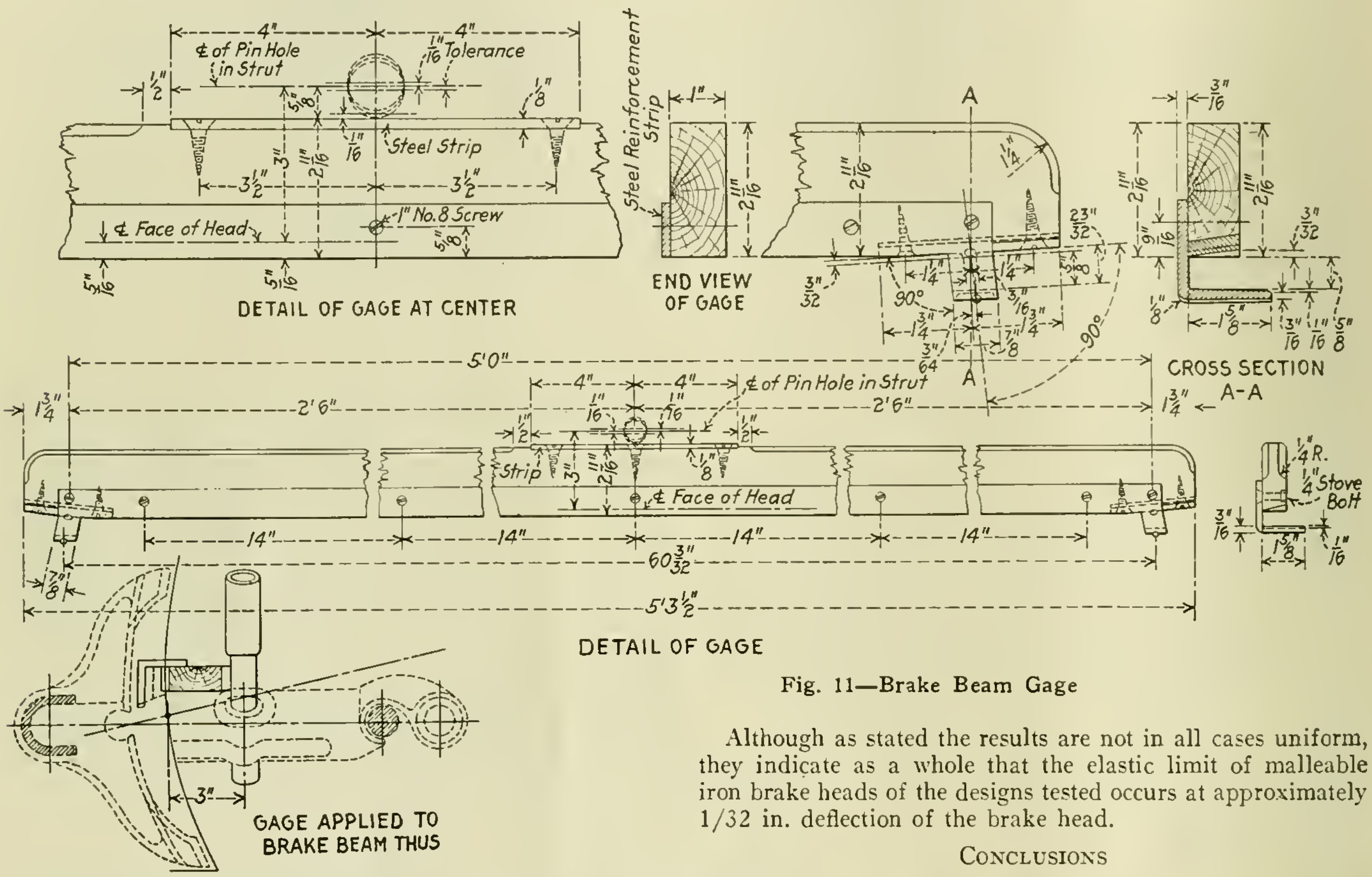


Fig. 11—Brake Beam Gage

Tests in each case were accordingly made by mounting the brake beams in the testing machine with the brake heads resting upon the radius blocks illustrated in the photographs, the load being carried upon the toes of the brake head, with the center lugs clear. Deflection of the heads was measured by apparatus designed by G. E. Doke for the New York Central Laboratory, also illustrated in the photographs. The datum bar of the deflection apparatus is clamped to the toes of the brake head, one end of this bar being free to allow the device to adjust itself to longitudinal spreading movement. The recording mechanism, an Ames dial gage reading to one-thousandth of an inch, is clamped to the lower center portion of the brake head, with the movable spindle in contact with the datum bar. This apparatus is self contained, and therefore measures only the deflection within the brake head, independent of any movement between the brake head and the support.

Twenty-one brake beams of various designs were tested by the sub-committee. Readings of deflections and the permanent set obtained upon brake heads were taken at the deflection loads and set loads required by the brake beam specification for No. 2, No. 2 plus and No. 3 brake beams, in addition to which the load and permanent set occurring at 1/32 in. and 1/16 in. deflection of the brake head were also noted.

Discussion of Tests—Condition No. 3

The results obtained are not consistently uniform. Loads appreciably in excess of the specified deflection load of the brake beam frequently produce distortions and twists in the several brake beam parts, that result in readings so variable and ununiform as to be of little practical value.

In numerous cases the strength of the head is not in proportion to the capacity of the brake beam; that is, for equal loads the brake heads of brake beams of higher capacity show more deflection than heads on brake beams of lower capacity.

Although as stated the results are not in all cases uniform, they indicate as a whole that the elastic limit of malleable iron brake heads of the designs tested occurs at approximately 1/32 in. deflection of the brake head.

Conclusions

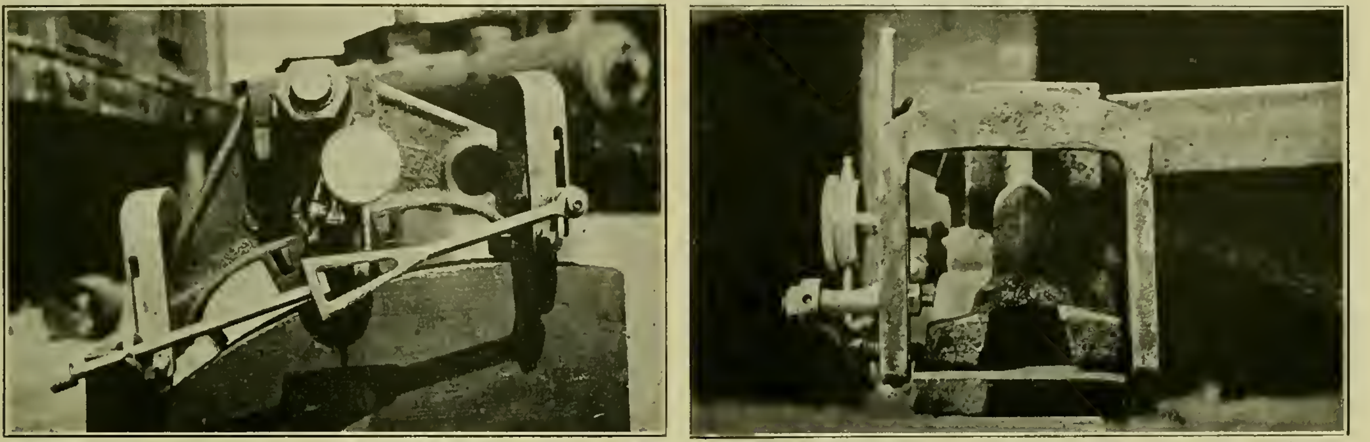
Tests of brake beam heads do not appear necessary if the load in service always comes upon the center lugs. However, if in the opinion of the Brake Beam Committee the load is not always restricted to the center lugs, but is frequently carried principally on the toes, then a standard strength of

Fig. 12—Brakehead Straightening Machine

head and standard method of test for determining same, is desirable. The information obtained indicates that this standard of strength can apparently best be determined under the method of support (3) described above. The elastic limit of malleable iron heads indicates that this standard should be approximately as follows:

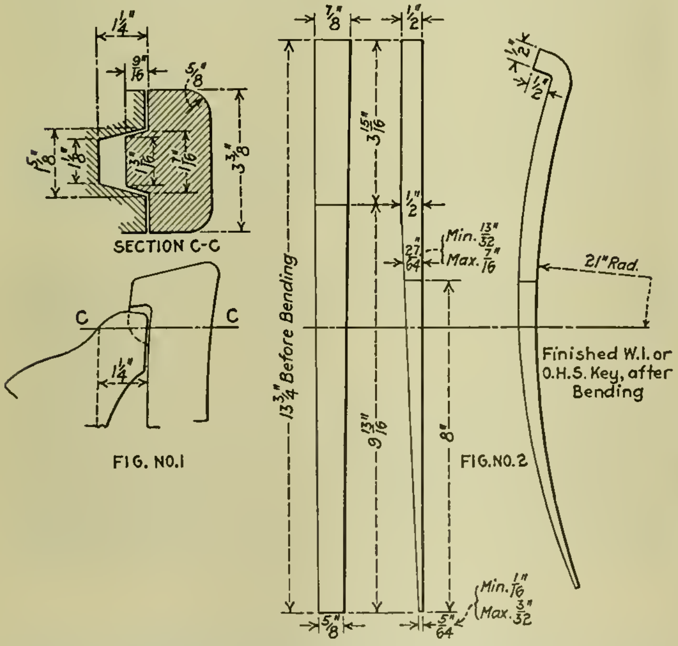
> When the deflection load specified for a brake beam of given capacity is applied to the brake beam, the brake heads themselves should not show more than 1/32 in. deflection, with no permanent set.

Whether a deflection of 1/32 in. of the brake head, which would increase the present permissible deflection of the brake beam as a whole by that amount, would so disturb existing brake rigging standards as to make it impracticable, must necessarily be decided by the Brake Beam Committee.



Apparatus for Measuring Brake Head Deflection

It is recognized that 50 per cent or more of present day designs of brake heads will not meet the above requirements, but if the load is frequently carried principally upon the toes of the brake head, then the sub-committee feels that such a requirement is logical, as otherwise the specification would permit permanent set at a given load in one member of the assembled brake beam, and at the same time require that the brake beam as a whole should show no permanent set at that load.



Proposed Dimensions for Recess in Toes of Brake Head and Proposed Design of Brake Shoe Key

G. E. Busse, chairman, Mechanical Committee of the Brake Beam Manufacturer's Institute, witnessed the above tests, representing the Brake Beam Manufacturer's Institute.

Exhibit C—Brake Shoe Key Design and Fit of Shoes, Head Faces and Key

The subject of brake shoe key design and details involved in the fit of the shoe, head, face and key was investigated by F. M. Waring who advises that an examination of a large number of freight cars in yards disclosed the almost universal condition of the keys being all the way down and still a loose fit, thus indicating the advisability of a change in the key design. The most logical change seems to be to make the key thicker at the center than is now specified. Fig. 2 shows a new design of key that has been tried out and is suggested for consideration.

The proposed key is thinner at the point and has a somewhat greater taper than the standard key, so that it becomes ½ in. thick at a point 3 15/16 in. from the end instead of just under the head. The drawing shows a tolerance of 1/32 in. in thickness, which is a practical working limit if the key is drop forged or rolled.

A key machined to the exact dimension shown was tried with new brake heads and shoes, which were selected by gaging, so as to give the maximum and minimum opening for the brake shoe key. With the maximum opening the experimental key could be pushed in by hand until the shoulder was within ¾ in. of the brake head. With the minimum opening the key stood out about 3⅞ in.

The key was then tried on a number of new brake beams and new shoes taken from stock and on a number of brake beams on cars in repair yards.

The table shows the distance the key protruded from the brake head when applied without being hammered down. When the key protruded several inches, it was found that it could be driven down about 1 in. further.

Fit of Experimental Brake Shoe Key

	—Number of keys—	
	New brake heads and shoes	Brake heads and shoes on cars in service
Loose when forced all the way in.....	0	4
All the way in before being tight......	0	55
Projecting from 0 in. to 1 in., inclusive.	0	2
Projecting from 1 in. to 2 in., inclusive.	0	8
Projecting from 2 in. to 3 in., inclusive.	13	9
Projecting from 3 in. to 4 in., inclusive.	7	8
Projecting from 4 in. to 5 in., inclusive.	0	7
Projecting from 5 in. to 6 in., inclusive.	0	2
Total	20	95

These figures show the desirability of a thicker key and they also show that it will be difficult to get a key that will fit old parts as well as new parts. However, the proposed key should be an improvement over the present standard and there will be only a few cases when it will be too large to be used. It is evident from experiments with brake heads or shoes which have been gaged that where the key projected over 4 in. from the brake head, the brake shoe or head is not within the limits of the standard gages.

When trying the proposed key on cars in service, the old keys removed were measured at a point 5⅜ in. from the head. Taking the measurements at a uniform place did not always show the greatest wear. However, 63 per cent of all old keys were only 5/16 in. or less. It would appear that a good deal could be accomplished in keeping the brake shoes tight by putting in a limit on the thickness of key which should be allowed to remain in service. We therefore suggest for consideration a limiting thickness of ⅜ in. at any place within 5⅜ in. of the shoulder.

Report of Committee on Tank Cars

During the past year the work of the committee has been mainly the continuation of its efforts to secure improvement in certain details of construction, principally the safety valve, bottom discharge valve, dome closure arrangement and anchorage of tank to underframe. In this work the Committee has had the benefit of the co-operation of the Bureau of Explosives, American Petroleum Institute and the National Petroleum Association.

Safety Valves

Additional tests have been made at Altoona of the experimental designs submitted by manufacturers of locomotive safety valves, which had been modified as the result of the tests referred to in the 1920 report; and also of other modifications of the standard design, including changes in the dimensions of the valve disks, non-corrosive seats, etc. The committee can only report progress for the reason that no valve has proved absolutely tight at pressures at or near the popping point (25 lb.). Observation of the leakage prior to popping has shown that the escape is always on one side, indicating a tendency of the valve disk to cock. Special guides have been tried and special springs have been made in an effort to secure true closure, but so far without success.

Some of the valve manufacturers are willing to make other modifications, but before asking them to do this the committee is endeavoring to get from the oil trade some definite information as to the extent of the losses which can be properly charged to the safety valve. The available data indicates that with straight refinery products the losses are not large; also that with insulated tank cars the loss with casinghead blends is slight, but the question of safety valve leakage assumes importance because the uninsulated car may carry very volatile products, some of which are constantly under pressure.

The tests have shown conclusively the large discharge capacity of the standard valve—about 31,000 lb., equal to 4,800 gallons of gasoline per hour—so that an 8,000-gallon tank with its two safety valves would be discharged in about 50 minutes with very little rise in the pressure. One of the experimental valves gave a discharge capacity of 40,000 lb. per hour.

The committee has approved some slight modifications in the details of the design of the valve to reduce foundry losses and to facilitate machinery. These changes do not affect the functioning of the valve, or the interchangeability of the parts, and the committee recommends that they be incorporated in the standard design of valve.

Bottom Discharge Valves.

This question has been assigned to a sub-committee of which J. E. Grant, special agent of the Bureau of Explosives, is chairman. This sub-committee is working in close cooperation with a similar committee of the American Petroleum Institute. There have been about twenty-five designs submitted, eleven of which are being tried out under observation in service. It is hoped that another year will demonstrate the correct principles on which satisfactory designs must be based.

Reports show that a large part of the unsatisfactory performance of existing valves is due to failure to keep the tanks and consequently the valve seat clean.

Extensions to Bottom Discharge Outlet

There have been a number of protests against the requirement adopted last year that:

> No nipples, valves or other attachments shall project below the bottom outlet cap, except while car is being unloaded.

These protests emphasize the lack of confidence in the present bottom outlet valves, in that it is claimed that the cocks attached to the bottom cap are necessary to enable the consignee to tell whether the outlet valve is closed, and that if the valve is not properly closed the removal of the cap would permit the uncontrollable discharge and loss of the contents of the tank. The trouble is really due to man failure rather than design failure. The regulations of the Interstate Commerce Commission require that the bottom cap shall be removed when the tank is loaded, and if this is done it will insure the valve being properly closed and there will be very little danger of its being unseated in transit. The one exception is where water from gasoline leaks past the valve into the outlet pipe and freezes, which may result in unseating the valve or breaking the outlet pipe, or both. The overcoming of this is one of the features of the problem of a satisfactory valve.

The committee believes a further step should be taken to guard against the danger of breakage of the outlet pipe by limiting the distance which the outlet projects below the sills to that required to operate a wrench in applying and removing the cap. It is, therefore, recommended that:

> Effective July 1, 1922, in the case of new cars and of replacements on existing cars, the bottom outlet pipe when applied to tanks of cars having center sills shall not project below the bottom line of sills more than the threaded length necessary to permit the application and removal of the bottom outlet cap.

The presence of a cock on the bottom of the discharge pipe is not necessarily objectionable, provided it complies with the proposed requirement.

[In connection with the bottom outlet, the committee also recommended the elimination of the following sentence from Section 7 (c), first paragraph, of Classes III and IV specifications: "Additional attachments thereto, having threads of other dimensions may be used."—Editor.]

Dome Closure Arrangement

The Bureau of Explosives takes strong ground against the ordinary screw type of dome cover, particularly for cars carrying liquid normally under pressure. It was expected that the escape of gas through the vent holes at the top of the screw portion of the cover would give adequate warning to a man of ordinary intelligence that internal pressure existed and that the dome cover should not be removed until this pressure had been relieved. The numerous casualties which have occurred because of the removal of the cover in spite of this warning show that a better form of cover is necessary.

There are also appreciable losses of contents in the form of gas due to lack of tighness of the screw cover, even where soft gaskets are used.

With cars assigned permanently to these very volatile products it would suffice to provide only such cars with another form of cover, but in an emergency, at least, any car may be loaded with these products.

The attention of the car builders has been called to the matter and a number of them are endeavoring to work out satisfactory designs. Two general types meet the requirements, viz.: (1) An internal cover supported by a screw and yoke against an inturned flange of the dome ring. Such a cover can not be removed while there is internal pressure. (2) An external cover held in place by a number of hinged bolts, the nuts of which engage lugs on the cover so designed that the cover can not be removed as long as there is internal pressure against it.

It may be necessary, eventually, to require that all new cars shall be equipped with some form of cover which can not be removed until internal pressure is relieved. The committee believes that a beginning should be made with cars carrying casinghead gasoline and its blends, and recommends that paragraph 6 (c) of the Class IV Specification be amended to read:

> For cars built after July 1, 1922, the dome cover, if external, shall be secured by bolts; or if internal, by yoke and screw.

The Committee feels that the external cover is preferable because of the greater probability of good workmanship and because its operation is simpler.

Anchorages.

The center anchorage for tank cars is the subject of a basic patent which expires in August, 1921. Because of this patent builders have been allowed considerable latitude in their designs of this type of anchorage. Some of these designs have proved unsatisfactory in service, and a number of cases have been reported of tanks going adrift with breakage of outlet pipe and loss of contents. So far these failures have been confined to the bolted anchorage and are traceable to bad design or workmanship, or both. The principal causes have been the use of rough bolts in unreamed holes instead of turned bolts in reamed holes, as required by the specifications; and the use of wooden fillers, prohibited by the specifications, between the anchorage and the underframe, so that the bolts are in flexure instead of in shear. In a number of cases the bolts were threaded so far down that the shearing value was that of the root of the thread instead of the body of the bolt, while the bearing value was but that of the top of the threads.

This matter was taken up with all of the tank car builders, and where it was found desirable to change the designs it was willingly done. The approved designs of all of the builders now provide connections materially in excess of the minimum requirements of the specification and it is believed that no failures of these anchorages will result with any reasonable handling.

Heater Pipes

The Committee can only report progress upon this subject.

Number and Class of Tank Cars

The growth in the number of tank cars is shown by a recent tabulation from Boyd's Tank Car Circular, which shows a total of about 137,000 tank cars in service, of which 125,500 were of private ownership and 13,500 of railroad ownership. This compares with figures for January 1, 1913, given in one of the Interstate Commerce Commission reports, viz.: 30,039 of private ownership and 9,150 of railroad ownership, a total of 39,189.

Welding

In its 1912 report the committee called attention to the desirability of the welded tank, and in 1919 provision was made in the specification to permit the experimental use of welded tanks for Class III cars. Several welding concerns have given the question attention, but so far the cost of tanks welded by the forge welding process has been so high as to be prohibitive. Recently one of the large pipe manufacturing concerns proposed the use of its forge welded pipe for this purpose. If this proposition assumes definite form your committee will be prepared to take up the question of this construction as an alternative to the riveted tank.

Various overtures have been made to permit the use of autogenously welded tanks, but the committee is not prepared to recommend the acceptance of such tanks in advance of definite proof of the reliability of this method of welding. At present there are too many uncertainties as to the character of the welds made by different operators, and particularly as to the ability of such welds to stand the alternating bending stress to which tank cars are subject.

The one exception which has been made is in the case of anchorages on welded Class V tanks. It was originally required that this should be forge welded, and during the War a number of tanks for the United States Government were so welded but the results were unsatisfactory. Owing to the nature of the lading, exposed anchorage rivets are objectionable and the latest construction approved by the committee consists of riveted anchorages with the rivet heads on the inside covered by autogenously welded cup shields.

In this connection the attention of the committee has been called to the fact that in some cases cracked shells have been repaired by autogenous welding and that the result has not been satisfactory. The committee recommends that, for the present at least, repairs to shells of tanks shall not be made by autogenous welding.

A. R. A. Standards and Recommended Practice

The specifications for Classes III, IV and V tank cars, under the head of Couplers, Brakes and Trucks, prescribe "A. R. A. Standards and Recommended Practice." It has developed that this, in connection with the Rules of Interchange, makes the standards and recommended practice mandatory in the case of tank cars where they are not so in the case of freight cars generally. It was not the intention of the committee to single out tank cars for greater compliance with the standards and recommended practice than is required in the case of other kinds of freight cars, and the committee recommends amending this requirement to read:

> A. R. A. Standards and Recommended Practice as in the case of other classes of freight equipment cars.

Brakes

Question has been raised as to the difference in the wording of the brake requirements for Classes I and II cars, reading:

> Each car shall be equipped with air brakes of a capacity equal to not less than 70 per cent of the light weight of car, and at least one hand brake operating the brakes of both trucks.

and those for later classes of cars, reading:

> A. R. A. Standards and Recommended Practice.

When the general revision of the specification was made in 1916 the committee, in accordance with its policy of avoiding as far as possible retroactive requirements, did not recommend any change in this respect so far as Classes I and II, which were the existing cars, were concerned. The difference is more in form than in substance, the original 70 per cent brake power being based on 60 lb., the pressure due to emergency application, while the 60 per cent is based on the 50 lb. due to equalized service application. As there is so little difference in the final results it is believed that the situation can be satisfactorily covered by adding, in the case of Classes I and II cars:

> When any change is made in the brake arrangement it shall be made to conform to A. R. A. Standards and Recommended Practice.

Tank Cars for Hydrochloric Acid.

Certain products such as hydrochloric acid, vinegar, etc., because of their chemical reaction can not be successfully handled in the ordinary metallic containers. In the case of hydrochloric acid, which is extremely corrosive, it has been handled in wooden tanks mounted on flat cars. The committee has not, so far, recommended any specification for such cars, but, at the suggestion of the Bureau of Explosives, in view of complaints as to leakage with existing designs of cars, the question of developing a standard specification has been taken up and a sub-committee of five representatives of the largest acid shippers in co-operation with the Bureau of Explosives is engaged in experiments with steel and wooden tanks with glass and rubber linings, and with wooden tanks enclosed in steel shells insulated by plastic bituminous materials.

The report is signed by A. W. Gibbs, chairman, Pennsylvania System; C. E. Chambers, Central Railroad of New Jersey; S. Lynn, Pittsburgh and Lake Erie; John Purcell, Atchison, Topeka & Santa Fe; George McCormick, Southern Pacific; F. K. Tutt, Missouri, Kansas & Texas; Col. B. W. Dunn, Bureau of Explosives; A. E. Smith, Union Tank Car Company; Geo. Hartley, Semet Solvay Company, and C. W. Owsley, The Texas Company.

Report on Train Brake and Signal Equipment

Retaining Valves for Freight Equipment

The question of retaining valves for freight equipment cars referred to in this committee's report of last year has been made the subject of a special investigation by a sub-committee, which outlined and arranged for a series of tests on grades ranging from 1½ to 3½ per cent, with retaining valves of various capacities. Owing to the serious business depression now generally prevailing, the tests were discontinued before sufficient information had been collected to permit the committee making definite recommendations.

Automatic Hose Connections for Freight and Passenger Equipment

The question of automatic hose connectors for freight and passenger equipment was referred to a sub-committee which reports that there were thirty-nine answers to the circular of inquiry sent out February 20, 1920, to all of the railroads in the United States; four railroads reporting experience with automatic connectors. Of these, there is only one which has any considerable number of cars equipped, or which are in any representative service. The committee learned that there were some automatic connectors used in Canada, which were not included in the answers to the circular, and endeavored to find what information could be obtained from this trial; but was unable to get any great amount of information.

The committee is unable to find in the reports a design that would seem to lend itself to general use, and for the lack of such information is, therefore, unable to make any specific recommendations at this time.

Air Brake Cylinder Packing

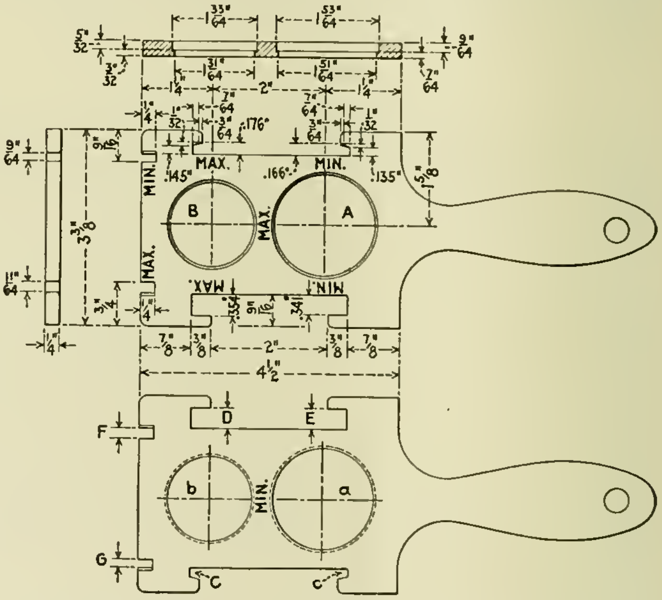
The committee has further considered the matter of air brake cylinder packing made of leather substitutes. It has also been recently suggested that specifications be prepared for brake cylinder packing. The committee will solicit the assistance and co-operation of the Committee on Specifications and Tests for Materials in preparing suitable specifications, after which it will be in position to submit definite recommendations.

Mechanical Sanders

The committee has considered the question of connecting mechanical sanders to the engineer's brake valve in a manner that will automatically sand the rails when the brake valve is placed in emergency position. This is a local matter and the committee has no recommendations to make.

Life of Air Brake Hose

This subject has been investigated by a sub-committee which has reviewed all data available. Unless the period for removal of air hose in service is extended to at least thirty months a large number of hose will be removed which would last for a much longer time; also the fixing of such a period for removal from service would not provide for removing a large number of hose which fail within this period. Instead of establishing a maximum life it would be preferable to consider revising the present specifications to provide a better quality of hose, and it is suggested that this be considered by the Committee on Specifications and Tests for Materials.



Openings "A" and "a" are for gaging max. and min. (external) diameter of packing ring flange.
Openings "B" and "b" are for gaging max. and min. (external) diameter of projecting wall or face portion of ring.
Slots "C" and "c" are for gaging max. and min. thickness of flange and bevel on surface of flange.
Slots "D" and "E" are for gaging max. and min. over all depth of ring at face.
Slots "F" and "G" are for gaging max. and min. thickness of projecting wall or face portion of ring.
Rings must enter all sections of gage marked "max." and must not enter any section of gage marked "min."

Fig. 1—Tolerance Gage for Air Hose Coupling Packing Rings

The committee again calls attention to the importance of applying the soap suds test as called for in the present rules governing the maintenance of freight brakes.

Extra Heavy Pipe and Nipples for Air Brake Train Line

A member has requested that consideration be given to using extra heavy wrought iron pipe and nipples exclusively for repairs to all freight car equipment, regardless of age, and that prices for material be revised accordingly. This practice is in effect on several large roads and while extra heavy wrought iron pipe is unquestionably superior to steel or standard weight pipe, in view of the decided difference in first cost the committee does not feel justified in recommending a change at this time. It is suggested, however, that standard weight nipples be used at the angle cock with either extra heavy or standard weight brake pipe.

Location of Angle Cocks on Locomotives

In view of the fact that this subject was investigated during the period of Federal Control by the Railroad Administration's Committee on Standards, assisted by several members of your Committee on Train Brake and Signal Equipment, without being able to develop a solution for the problem, the committee is not now in position to develop anything new on the subject.

Gages for Air Brake Hose Couplings and Packing Rings

The Committee on Specifications and Tests for Materials has recommended that, (*a*) suitable gages be developed for checking the dimensions of hose couplings when new, (*b*) consideration be given to changing the form of present standard gage for hose coupling packing rings, and (*c*) the tolerance dimensions for packing rings be made to conform to the tolerances shown in its report for 1919, which was printed in Circular S III-23.

With one exception the tolerance dimensions referred to are practically the same as are now provided for in the standard gage for hose coupling packing rings, the exception being that the gage provides for no tolerance in thickness of packing ring flange. The Committee on Train Brake and Signal Equipment now believes it desirable to provide for tolerances for all dimensions, and recommends that the gage drawing be revised to conform to the accompanying Fig. 1.

It is suggested that the question of gages for hose couplings be made the subject of investigation by this or a similar committee during the coming year. The Committee on Specifications and Tests for Materials concurs in this suggestion and has consented to furnish a sub-committee, if necessary, to assist in such an investigation.

Adjustment of Hand Brake Power on Freight Cars

On account of the present business depression in railroad service, the test which was scheduled to be made early this spring in connection with the adjustment of hand brake power on freight cars has, with the approval of the General Committee, been indefinitely postponed.

The report is signed by T. L. Burton (Chairman), New York Central; B. P. Flory, New York, Ontario & Western; J. M. Henry, Pennsylvania System; L. P. Streeter, Illinois Central; R. B. Rasbridge, Philadelphia & Reading; G. H. Wood, Atchison, Topeka & Santa Fe; H. M. Curry, Northern Pacific; W. J. Hatch, Canadian Pacific, and G. C. Bishop, Long Island.

The Use of Powdered Fuel Under Steam Boilers

Summary of Present Installations; Results of Tests; Information Obtained from Operation

A very complete summary of the developments which have been made in the use of powdered fuel under stationary boilers was given in a paper presented by H. D. Savage of the Combustion Engineering Corporation, New York, before the American Iron & Steel Institute at its last meeting.

The primary object of the paper was to give a digest of the work that has been done in the last three years in equipping steam power plants for burning powdered coal, to record the progress in making the use of powdered coal for steam production reliable and efficient and to present the economic possibilities of this method of combustion.

Preparation and Handling Equipment

Two mills, known as the Raymond and the Fuller have become practically the standard for pulverizing. Each of these mills is built in sizes of from 2 to 6 tons an hour rated capacity when grinding to a fineness so that 95 per cent will pass 100 mesh and 82 per cent through 200 mesh and using bituminous coal containing less than 1 per cent of moisture. The power consumption is from 15 to 20 hp. per ton per hour of bituminous coal ground to above specifications. The maintenance will approximate 5 cents a ton when grinding bituminous coal and much higher when grinding anthracite. Tube mills or ball mills, generally employed in the early days for this work, have been gradually replaced. A new mill is being developed at the present time employing air separation but otherwise differing entirely in type and principle from any of the present standard methods.

There are two types of dryers, the single-shell and the double-shell. The latter has several advantages, such as larger capacity, better efficiency and greater freedom from internal fires. The first cost is not greatly different for either of the two types. The most widely used method of transporting coal from the pulverizing plant to the boiler bins is the screw conveyor, but air transport systems are at the moment meeting with much popular favor. Of these systems the Fuller-Kinyon pump is probably the simplest. It is essentially a high-pressure feeder, consisting of a hopper, high-speed screw and a delivery nozzle. Air is brought into the coal at about 40 lb. pressure and forced through pipes of varying sizes, depending on the capacity for which the pump is designed.

Typical Installations

The first commercial installation of any considerable size was at the Oneida Street plant of the Milwaukee Electric Railway and Light Company, at Milwaukee, where five Edge Moor boilers, each of 468 nominal horse-power capacity, were equipped in 1918. This plant, which is a combined heating and power plant, has been in operation for nearly three years with no unusual operating difficulties and with no interruptions to service due to powdered coal operation.

At the plant of the Allegheny Steel Company, Brackenridge, Pa., there are equipped nine 333 hp. Wickes boilers and two 600 hp. Stirling boilers. The boilers have been in operation for about two and one-half years, and have met all requirements of a widely fluctuating load, which is characteristic of steel plant operation, with large fuel and labor savings. Additional boilers are now being installed. An unusual feature of this installation is the fact that no dryers are used. The company mines its own coal adjacent to the plant and the coal contains less than one per cent moisture as it comes from the mine. The pulverizing plant is approximately 350 ft. from the boiler room and although the screw conveyor used to transport the coal is exposed to the elements no difficulties have been met with due to lack of dryers.

The Lima Locomotive Works, Lima, Ohio, have equipped six 400 hp. Wickes boilers, one 500 hp. Heine boiler and one 500 hp. waste heat Wickes boiler.

At the Oklahoma City plant of Morris and Company, there are five 500 hp. Edge Moor boilers and two 300 hp. Edge Moor boilers. A distinguishing feature is the ability to operate on either natural gas, fuel oil, or powdered coal—whichever the condition of the market warrants as being most economical. A change from one fuel to another can be made in about five minutes.

The St. Joseph Lead Company, Rivermines, Missouri, has equipped two Stirling boilers of 768 hp. each which have now been in operation for a few months. They are being operated at from 200 to 225 per cent of rating, with flue gas temperatures of 580 deg. to 609 deg. F. The new Lakeside plant of the Milwaukee Electric Railway and Light Company has eight 1,308 hp. Edge Moor boilers, two equipped with the Fuller system and six with the Lopulco system.

Another interesting application just now nearing completion, is at the River Rouge plant of the Ford Motor Company, where powdered coal is being installed in connection with four Ladd boilers of 2,640 nominal horsepower each. These Ladd boilers are the largest that have as yet been built and are intended to operate normally at from 200 to 250 per cent of rated capacity. The boilers will operate on a combination of blast furnace gas and powdered coal and the design is such that these fuels can be used either separately or in combination, as conditions require. In this installation, the gas is introduced horizontally at a lower level than the coal and through the medium of an especially designed grid burner. Another installation is at the plant of the Bethlehem Steel Company, Lebanon, Pa., where four 520 hp. Babcock and Wilcox boilers have been in operation approximately one year. These boilers are operated at around 175 per cent. The British Columbia Sugar Refining Company at Vancouver have equipped two 504 Badenhausen boilers, two 250 hp. Babcock & Wilcox, nine 110 hp. horizontal return tubular and two 500 hp. Stirling boilers. It is understood these are being operated at around 150 per cent of rating. The Puget Sound Traction Company at Seattle, Wash., have ten Babcock & Wilcox boilers from 300 to 600 hp. which have been in operation about two years. The plants mentioned are, we believe, the only ones of any considerable size that are in actual commercial operation, although of course, a number of small isolated boilers and some waste heat boilers are in operation in connection with powdered coal.

Tests and Operating Results

Included in the paper are many tabulations of the results of various tests which have been conducted at the different plants mentioned. Some of these tests were conducted by engineers of the local plants, some by the U. S. Bureau of Mines and others by the Combustion Engineering Corporation. As the plants are located at widely separated points they naturally operate on a wide range of fuels and under very different operative conditions. The test reports and the operative figures would indicate that the results obtained are very generally satisfactory. From these tests important information was obtained in regard to the effect of fineness and the amount of moisture in the coal.

Other Factors

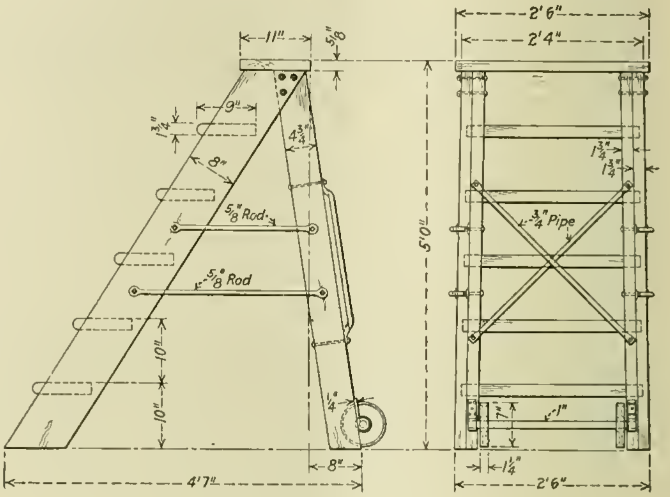
Additional points taken up in the paper include the design and construction of furnaces, burners and feeders; the advantages and disadvantages of firing direct from the pulverizer; the costs of installation; slagging, deterioration of brick work and ash disposal; also a comparison of operating costs between stoker equipped plants and these arranged to burn powdered coal.

Step Ladder for Car Shops

BY AUSTIN G. JOHNSON

Mechanical Engineer, Duluth & Iron Range

Step ladders for use in car shops should be strongly constructed with the legs spread well apart in both directions to make them as stable as possible. It is difficult to meet these requirements without increasing the weight of the ladder so much that one man cannot handle it. This difficulty has been overcome in the design used in the shops of the Duluth & Iron Range, which is shown in the drawing. The feature of the ladder is the pair of wheels placed on the back legs. These wheels are off the floor when the ladder is in use, but when it is to be moved the ladder is tipped back so that the wheels come in contact with the floor. In this position the ladder can be handled like a wheelbarrow and one man can easily move it from place to place.



A Ladder Which Can Easily Be Moved by One Man

Boiler Ruptures With Man in Firebox

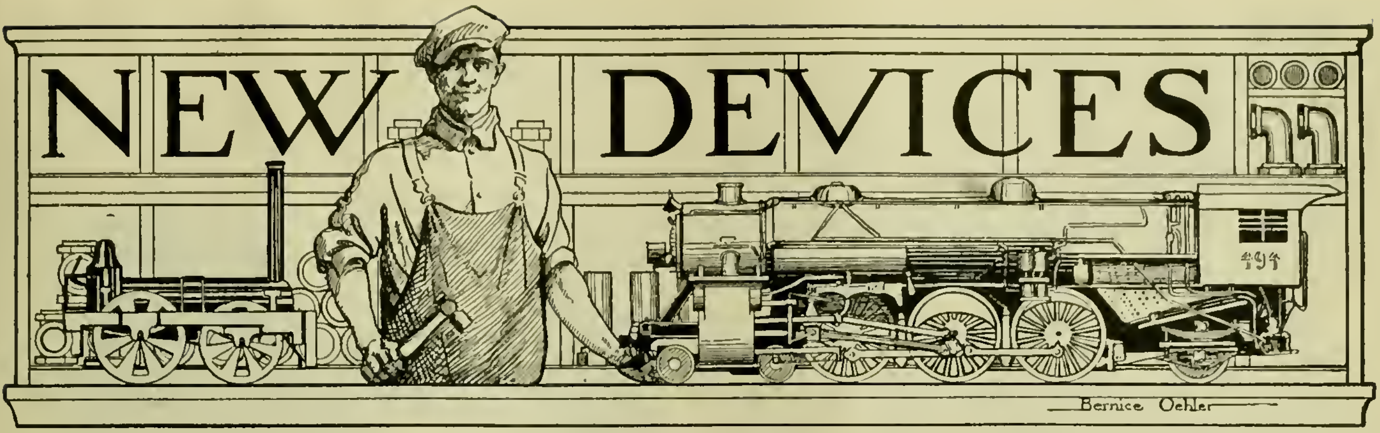
Here is a real freak story—the case of a boiler that "went up" while an inspector was going peacefully about his work in the firebox, and with no pressure up.

The boiler was of the stationary locomotive type and had been out of service a long time. At the time of the explosion the inspector was inside the firebox searching for defects, and he certainly found one. He was naturally rather startled to hear a report like the discharge of a cannon and at first thought that a stick of dynamite had exploded. He found, however, that a furnace sheet had ripped open for a length of about 36 in. directly through a weld that had been made in the sheet. The rupture extended about equal distances on either side of the part built up by welding.

The explanation of this peculiar occurrence is thought to be that the sheet had been overheated in the welding process, crystallized, and was therefore under a severe shrinkage strain. The defective part was practically free of scale. The handhole plates at the bottom of the boiler were off, but the manhole plate had been replaced.

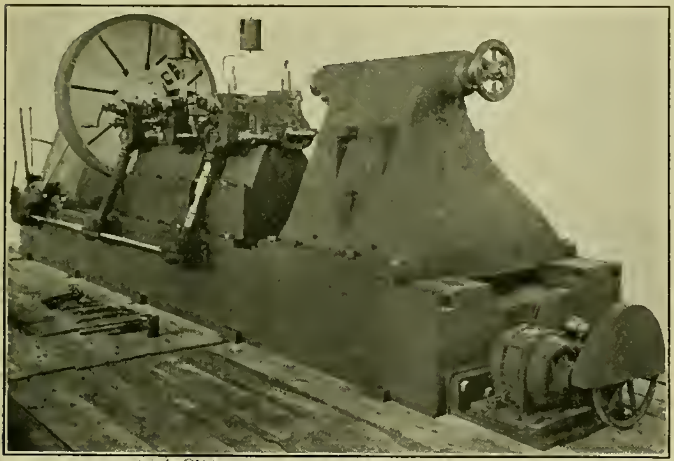
According to the inspector the condition represented by this boiler, so strikingly demonstrated in this case, may have resulted in some disastrous explosions that have occurred, the causes of which have never been determined. The incident is certainly a forceful demonstration of the dangerous stresses that may result from improper heating in the welding process.

This is an authentic report published in *Power* of an occurrence at the plant of the Calco Company, Bound Brook, N. J., where the two boilers were examined by an inspector of the Fidelity and Casualty Company for the Standard Bitulithic Company, who contemplated their purchase.



Adaptable 90-In. Journal-Turning Lathe

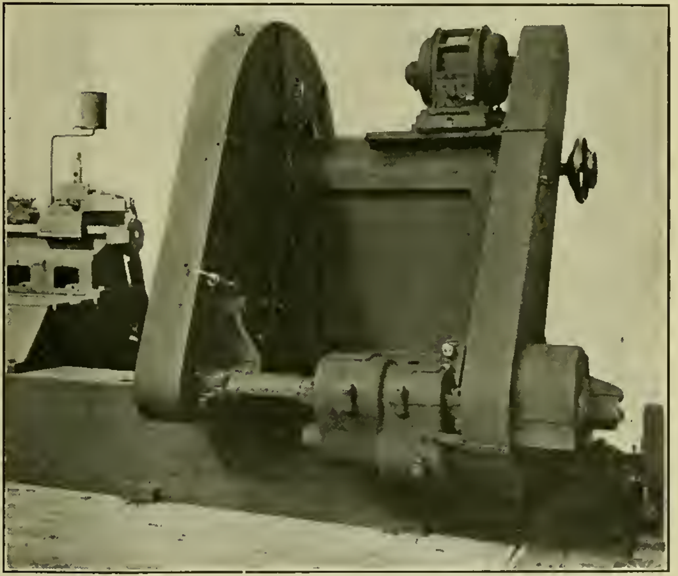
IN view of the unavoidably high cost of heavy machine tools it is essential that they be used as large a proportion of the time as possible and this object is the more easily accomplished the greater the number of operations that can be performed on one machine. Adaptability is a valuable feature of the new 90-in. locomotive journal-lathe made by the Niles-Bement-Pond Company, New York. The machine has a swing of 90 in. to take the largest driving wheels and can be used to turn either driving or trailer wheel journals with the wheels mounted. Provision is also made to turn crank-pins in place or to bore crank-pin fits in wheel centers.


General View of Niles-Bement-Pond 90-In. Journal-Lathe

The machine in general consists of a bed on which is mounted a headstock, tailstock and carriages, and to facilitate getting the work into the machine, both the headstock and tailstock are adjustable along the bed. The machine is arranged to turn two inside journals at one time, or one outside trailer journal, it being necessary to reverse the wheels when the opposite trailer journal is being turned.

The machine is driven by a 15-hp. motor, mounted on the headstock and carried on slide rails. Drive from the motor passes through the medium of a belt to a back shaft carried in ring oiling bearings, mounted on the back of the headstock. The jackshaft drives through a speed box but at high speed the drive is directly through the jackshaft. By means of a positive tooth clutch and through sliding gears in the speed box, three other changes of speed are obtained. The pulley on the jackshaft is provided with a friction clutch which eliminates the necessity of stopping the motor when changing speeds. On the forward end of the jackshaft is carried a pulley from which power is transmitted by a belt running directly around the face-plate. A tightener pulley is supplied for this belt and is held up to engagement with the belt through the medium of a compression spring. This double belt drive as described performs a valuable function in tending to eliminate chatter and tool marks on the turned journals. Suitable sheet iron or woven guards protect the belt leading from the motor to the jackshaft, as well as the belt leading from the jackshaft to the face-plate. A 6-in. belt is used to drive from the motor to the jackshaft and a 6-in. belt from the jackshaft to the face-plate. The face-plate speeds obtainable are from 20 to 60 r.p.m.

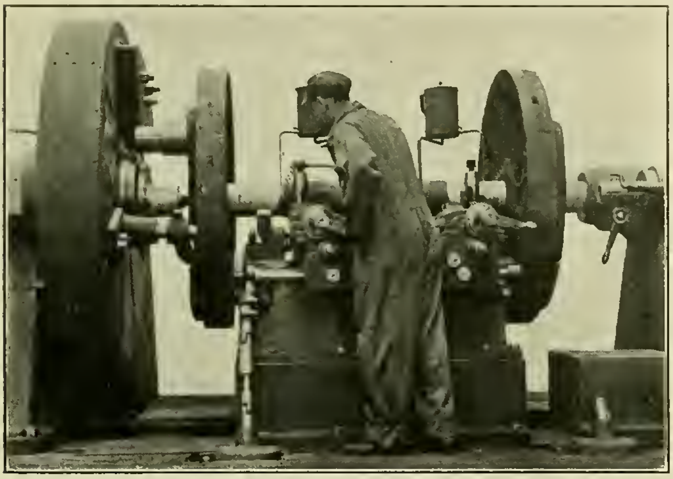
The levers for controlling the friction clutch and speed changes are brought to the front of the machine within easy reach of the operator. The face-plate revolves on a stationary spindle member, and with this construction the headstock center is a dead center. The tailstock is of the type usually furnished on large engine lathes and merely supports the work on an adjustable spindle which is arranged to be clamped.


Rear View Showing Method of Driving

The carriage details consist of a large base, located in a fixed position between the driving wheels. On this base are mounted two sets of carriage rests and tool slides for turning simultaneously two inside journals, up to 22 in. long. The tool rests have power longitudinal feeds and power cross feed for facing hub liners. For turning outside journals a separate rest is provided which is mounted on a base adjacent to the tailstock.

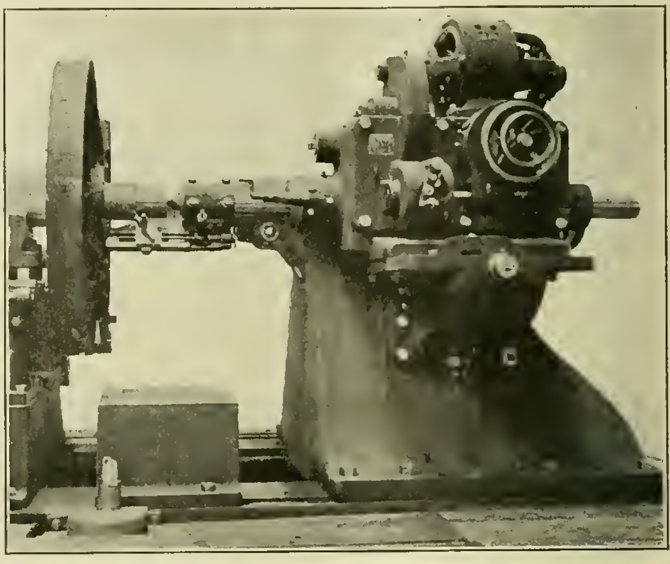
The feed is driven from a gear whose teeth are cut directly in a steel bushing member carried in the face-plate. This gear engages a gear carried on a shaft brought up to the front of the headstock, and from this shaft, through a medium of bevel gears and a diagonal shaft, feed is transmitted through a feed box where feed variation is obtainable, and from the head through a spline shaft extending along the front of the bed. From this shaft power is transmitted for either the inside or the outside journal turning operations.

Provision is made so that hub liners may be faced by either hand or power feed. The journal turning operations also have both power and hand feed. The carriage detail parts are arranged so that burnishing tools may be used for either the inside or outside journals. For turning driving axles, an attachment is furnished arranged to be bolted to the face-plate and adjusted radially, and having an extended arm which projects out between the spokes of the driving wheels and clamps around the spokes. When the driver sets are in place in the machine the headstock is properly supported in a suitable bushing carried in the stationary spindle.


Turning a Pair of Inside Journals

When trailer sets are to be turned, the left-hand journal is pocketed into the recess in the fixed spindle and the adjustable spindle drawn back into the stationary spindle, so as to properly support the axle. The other end of the axle is carried on the tailstock spindle. Trailer sets are chucked by the same means as the driver sets.

The face-plate is made so that, in itself, it is practically perfectly balanced, and therefore when handling trailer sets, the entire job will be in balance, insuring smooth journals free from chatter marks. An adjustable counterweight is furnished for the face-plate so as to accurately balance up the entire job when turning journals of a pair of drivers. This adjustable counterweight may be set in one of two positions so as to properly balance up wheels with either a right or left-hand lead.


Crank-pin Turning or Boring Attachment

In order to facilitate the work of getting either drivers or trailers into the machine, both the headstock and the tailstock are made adjustable along the bed by means of 5-hp. motors through the medium of friction clutches, thereby allowing the carriage bases to remain in a fixed position. In addition to journal turning, the machine is also arranged so that quartering attachments can be bolted to both the headstock and tailstock, as well as a crank-pin turning attachment.

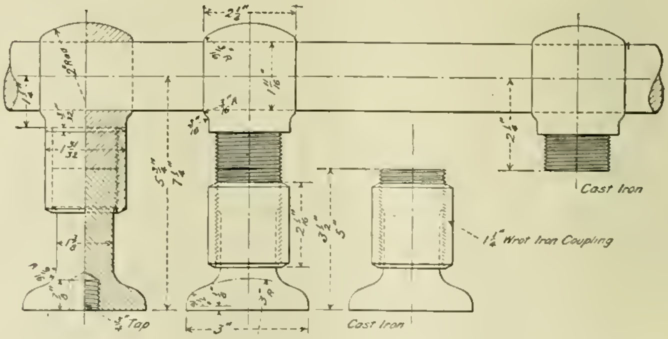
The maximum swing of the lathe is 90 in., the maximum distance between the face-plate and tailstock center being 10 ft. and the maximum distance between the centers 11 ft.

Easily Detachable Hand Rail Column

THE illustration shows a new hand rail column designed for strength and reliability and at the same time intended to be easily detachable. It has proved its value by extended tests on locomotives under actual service conditions.

As in the case of the ordinary type of one-piece hand rail column, a stud, screwed into the boiler shell, extends outward through the lagging and jacket and engages the base of the column. The column itself consists of three parts: first, a bottom section of cylindrical form with a base enlarged and provided with a threaded socket to receive the stud, the opposite end of the bottom section being threaded to engage the standard pipe coupling which joins the two sections of the column; second, the loop or eye portion of the column is threaded at its lower end to engage the pipe coupling previously mentioned; third, a 1½ in. pipe coupling joins together the top and bottom sections of the hand rail column. The relation of the respective parts to one another and the method of disconnecting the upper and lower sections are plainly shown in the illustration.

This hand rail column is neat in appearance and enables the workman to disconnect the top and bottom sections of the column, move the eye or loop portion of the column out of the way, unscrew the base section and detach the jacket, lag-



Simplicity and Easy Removal Feature New Hand Rail Column ging and so forth and perform necessary work on the shell of the boiler without disconnecting or removing the hand rail.

Many railroads utilize hand rails as conduits for head light wiring and the sectional hand rail column avoids the necessity of removing these wires preliminary to lagging removal. An additional advantage is due to the fact that the sectional hand rail column allows the hand rail itself to be made in one piece, if desired. This provides a safer rail than is sometimes the case where short sections are used. In the case of railing on the front end of the smoke box, the rail can be removed and repaired without opening up the front end.

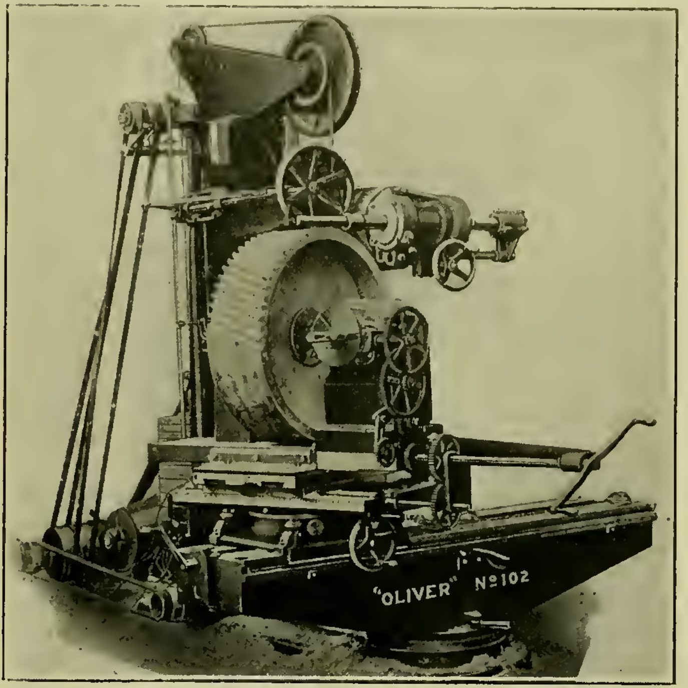
Practical experience with this type of sectional hand rail column has indicated that it is just as safe as the solid one piece type and that the labor saved on occasions where repairs are to be made which require the removal of the jacket will pay for the improved type of column within a short time. This device is covered by a patent, held by C. B. Baker, 3865a Flad avenue, St. Louis, Mo.

Device for Cutting Gear Pattern Teeth

THE Oliver Machinery Company, Grand Rapids, Mich., has recently developed a special attachment for its No. 102 pattern milling machine, to aid in cutting spiral, spur, bevel and worm gears. As shown in the illustration this attachment includes a 14-in. universal dividing head with tail stock, index plate, index chart, two face plates, a set of raising blocks, recessing change gears, quadrant and connecting mechanism between table and dividing head. The machine is so arranged that in cutting spirals the grea pattern rotates according to the spiral as the cutting progresses from the back to the front edge. This produces an accurate tooth form which would be extremely difficult to produce by hand.

The pattern shown in the illustration is for a spiral gear 33 in. in diameter and having a 10-in. face. By means of this gear cutting attachment all teeth are machined alike and uniformly spaced and the time required for the operation is obviously much less than would be needed to form the teeth by hand. In addition the accuracy obtained is greater.

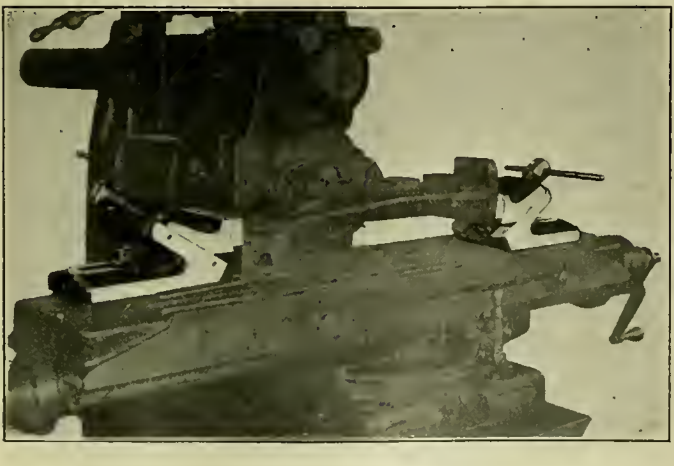
While railroad shops would seldom if ever be required to make patterns as large as the one illustrated the device can be used for smaller gear patterns of various kinds and is distinctly a time and labor saving device. Where conditions are such that any considerable number of gear patterns are to be cut the device is one which will save its cost many times over.



Oliver Gear Pattern Cutting Attachment

Divided Machine Vises Adjustable in Height

THE divided machine vises illustrated are adjustable in height and have an unlimited length of span. They have been developed recently for use on planing, milling, shaping, drilling, and other machine tables in place of the ordinary parallel vises, clamps and bolts. As shown they overcome the common deficiency of limited base plate lengths. The jaws can be placed parallel or crosswise or in any other position required by the shape of the work and are adapted to holding parallel, taper or irregular parts. The depth of the jaws from the top to the bottom is considerably greater than in ordinary vises and enables top-heavy work to be clamped with security.



O. Z. Divided Machine Vises

The body and jaw of each vise is made of cast iron, the jaw being faced with hard steel, with a serrated surface to afford a good grip. The screw is made of steel with right and left-hand threads; the left-hand threads run in a solid nut on the moving jaw, and the right-hand in the nut secured to the body. Therefore for each revolution of the screw a movement of the jaws is obtained equal to twice the pitch of the screw, thus insuring rapid action. The jaw is held to the body by a sliding V, properly fitted and an adjustable steel gib and screws provide the necessary adjustments for wear.

In operation the combined parallel and downward movement of the two jaws forces the part held down to the table or parallels and saves the operator from using a hammer, an objectionable practice. The divided machine vises are made by O. Zernickow, New York, and can be furnished in three sizes with jaw widths of 2 3/16 in., 5 in. and 10 in., respectively. The heights of the vise jaws in the top position are 2½ in., 4½ in. and 7 in., the length of table occupied by each jaw being 4½ in., 8½ in. and 13 in., respectively. The vises are supplied complete with operating levers and as the parts are interchangeable new parts can be ordered to replace damaged ones. The largest size of the machine vises is provided with two slots and four cross plates, so that it will suit tables with varying distances between slot centers.

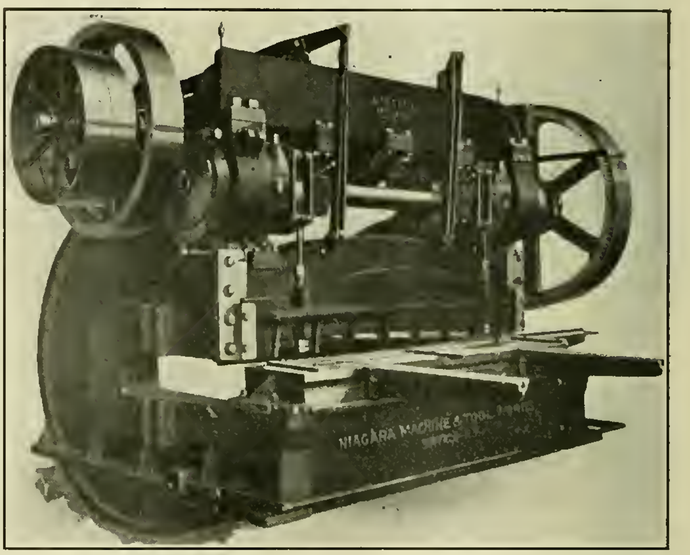
Power Sheet Metal Squaring Shear

The Niagara Machine & Tool Works, Buffalo, N. Y., has recently developed a power squaring shear designed to cut sheet metal up to ⅝ in. thick by 96 in. long. The crosshead of the machine is heavy and of the box section type. It is guided in broad, liberally proportioned ways, the proper arrangements being made for counter-balancing. The main shaft and eccentrics are forged in one piece from a tough grade of steel. The clutch block is made of a hammered steel forging and is equipped with hardened and ground removable striking jaws, as well as with hardened back-lash jaws. The clutch wheel is bronzed-bushed and provided with hardened and ground removable striking faces with a back-lash pin. The center bearings for the main shaft are two in number, placed as close as possible to the eccentrics and holddown cams so as to give the greatest possible support. Cams are provided to lift the holddown positively, as well as to hold it down positively. These cams are liberally proportioned and bear against hardened steel rollers lubricated through hollow pins. The holddown rods are provided with springs to compensate for various thicknesses of plates.

Brakes, lined with asbestos fibre are furnished, the brakes being made in two hinged halves and equipped with an automatic spring take-up for wear.

The bed of the machine is exceptionally wide and heavy, being screwed and doweled in place. The housings are of massive construction and do not require stay rods for cutting the maximum capacity rating. Stay rods and stay rod lugs are furnished on special order only. All gears for this machine are cut and provided with suitable guards. The pinions are made of hammered steel and are large enough to afford ample bearing surface and long life. Counter-balance rods are regularly placed so as to pass outside of the housings and not to interfere with the work. A complete set of front, side, bevel and slitting gages is provided; also a patented automatic screw adjusting back gage.

The driving mechanism for the machine is overhead, out of the way of the operator. Pressure of the cutter bar toward the back is taken up by solid metal and not by loose gibs. A 30-hp. motor is required to drive this power squaring shear in conjunction with a double gear giving a ratio of 15 to 1. The flywheel is 52 in. in diameter with a 9 in. face and weighs 2,300 lb. The pulleys are 36 in. by 9 in. and run at a speed of 240 r.p.m. With a 24-in. gap this machine weighs 54,000 lb. and with a 36-in. gap 61,000 lb. The floor space required is 132 in. by 197 in., the overall height being 123 in.



Niagara Power Squaring Shear

Eliminating Blow Holes in Thermit Welds

A NEW grade of molding material has been developed recently by the Metal & Thermit Corporation, New York, and used to prevent blow holes and assure sound Thermit welds. It is designated as "Thermit Molding Material," being quite different from ordinary molding material, and is recommended for all Thermit welding work.

The design of the new molding material is based on the theory that good silica sand will stand the heat of the Thermit reaction and that the weakness in all molding material is the clay binder. There should be as little clay as possible in the mixture in order to make the mold more refractory and to increase its porosity and it is logical, therefore, to use plastic clay instead of a fire clay, as formerly. The sand and plastic clay are ground together in a foundry pan or Moller, with the intention of coating each grain of sand with a minimum thickness of clay. This has resulted in a good, clean molding material which should be rammed hard in the mold. It will stand up well under the preheating flame, and is extremely porous to the gases generated in the mold, resulting in a sound weld with a clean exterior. Although suitable molding material can be made by increasing the clay content slightly and mixing the clay and sand thoroughly by hand, it is not as good as that made with a smaller clay content in the foundry pan or Moller.

The mixture now being used is composed of the following: 3 parts of clean, sharp silica sand, (100 per cent of which should pass through a screen having a .03 in. square opening, and 40 per cent of which should be retained on a screen having a .012 in. square opening) mixed with 1 part Welsh Mountain plastic clay. These parts are first thoroughly mixed in the Moller together with 1/40th part glutrin by volume and sufficient water (1/12th part) to bring the mixture to the proper consistency. If mixed by hand, the sand and clay must be dried before mixing (being careful not to subject the clay to a temperature higher than 400 deg. F.) and thoroughly mixed before adding the glutrin and water. The glutrin should be mixed with the water before adding to the sand and clay.

In case a plastic clay, fatter than the Welsh Mountain, be used, the mixing will have to be more thorough and less clay will be used. Welsh Mountain clay is being used in the present mixture because in carefully run tests it has proved to be the most refractory. The use of the new molding material necessitates harder packing next to the weld; in fact, the regular Thermit rammer may be supplemented by the use, for instance, of a tool having an end ⅜ in. by 1½ in., so that the operator may be able to peen the sand next to the wax collar and the various patterns.

It is absolutely essential, in the production of sound welds, to be sure that no loose sand exists in the mold when the Thermit steel is poured. This is why very hard ramming is advocated, also why it is most important to blow out all loose material from the interior of the mold by putting the preheating burner in the riser before the heating gate is plugged and being sure that no sand is detached by the operation of inserting this heating gate. The burner should be removed from the riser before plugging the heating gate, because otherwise it may detach some sand, which could not be blown out after the plug is in place. The heating gate plug should be thoroughly dry, and if it has been carried in stock for some time it should be warmed before using.

By perforating the sides and bottom of the mold box, the escape of the gases which pass through the molding material is greatly facilitated. Holes ⅜ in. in diameter, spaced 3 or 4 in. apart, are sufficient. To facilitate the escape of gas from the bottom of the mold box, the mold should rest on blocks, not directly upon the foundry floor. As unnecessary molding material simply increases the resistance to the passage of gas, the mold box should be made as small as possible commensurate with safety. For example, in welding a 4 in. by 4 in. section, only about 4 in. of sand is necessary at all points, except, perhaps, on the pouring gate side. It is most important to thoroughly vent the mold box by forcing a rod or wire down at a number of points to within about ½ in. of the collar. Precautions should be taken, however, that these do not touch the collar because such vent holes will fill with steel and will therefore prevent instead of facilitate the escape of gas.

Cold Junction Compensated Pyrometer

THE feature of a special interest in a new thermo-electric pyrometer, placed on the market recently by the Brown Instrument Company, Philadelphia, Pa., is the method of automatically compensating for changes in cold junction temperature. This is an improvement on the method of cold junction compensation developed by Darling in England in 1909. Darling used what is called a Briguet spiral, or compound strip of two metals of different coefficients of expansion, but no means was afforded for setting the instrument to zero. The new patented Brown construction includes a method of setting the instrument to its proper zero, this being clearly shown in the illustration.

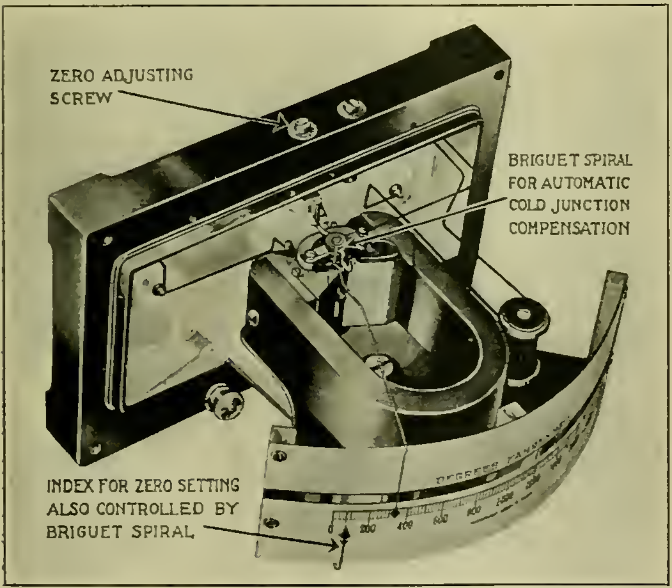


Fig. 1—Brown Compensated Pyrometer

The milli-voltage or e. m. f. developed by a thermo-couple is dependent on a difference in temperature between the hot and cold ends of the thermo-couple. To secure accurate measurements of temperature, it is therefore necessary that the cold end of the thermo-couple be maintained at a constant temperature or the instrument must be compensated for changes in temperature at the cold junction of the thermo-couple. It is common practice to use what are known as extension or compensating leads, as shown in Fig. 2, which will transfer the cold junction from the binding posts of the thermo-couple to a distant point. Heretofore, it has been necesary to locate the cold junction at the end of the extension of the compensating leads in a cold well in the ground or in a compensating box, where the temperature can be maintained constant. In the new Brown pyrometer the extension or compensating leads are brought to the meter. Changes in temperature at the end of the extension or compensating leads also take place in the meter itself, which is compensated for this change in temperature.

A Briguet spiral similar to that used by Darling is mounted in the instrument as shown and controls the springs and moving elements directly. A second index is provided which works with changes in temperature exactly in relation to the movement of the pointer controlled by the Briguet spiral attached to the moving element. After mounting the instrument the pointer is set by the zero adjusting screw to correspond with the index on the scale. If the values for a thermo-couple have been determined, based on a cold junction of 75 deg. F., the index will indicate 75 deg. F., provided the instrument is subject to this surrounding temperature. If the instrument pointer does not correspond with this index it is set accordingly. When the temperature surrounding the instrument and the cold junction of the end of the compensating leads at the instrument rises to 90 deg. F., the index automatically rises to 90 deg. F., and the Briguet spiral attachment to the instrument pointer causes it to move up to 90 deg. F., automatically adjusting for the temperature of the cold junction of the thermo-couple.

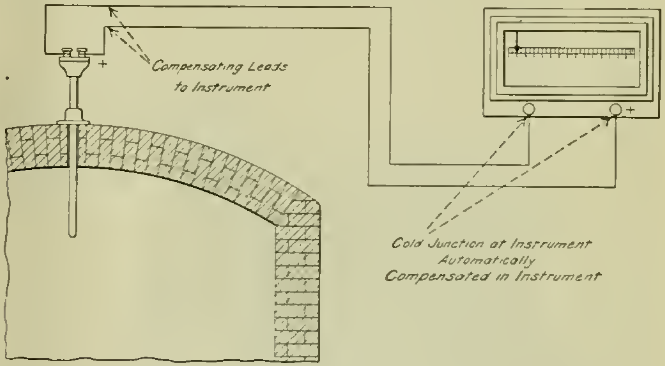


Fig. 2—Diagram Showing Use of Compensating Leads

Any number of thermo-couples with their extension or compensating leads can be brought to the one instrument having this automatic compensation. Likewise, recording instruments can be equipped with automatic compensation and means for offsetting the pointer to zero.

Gantry Drill for Tank Car Work

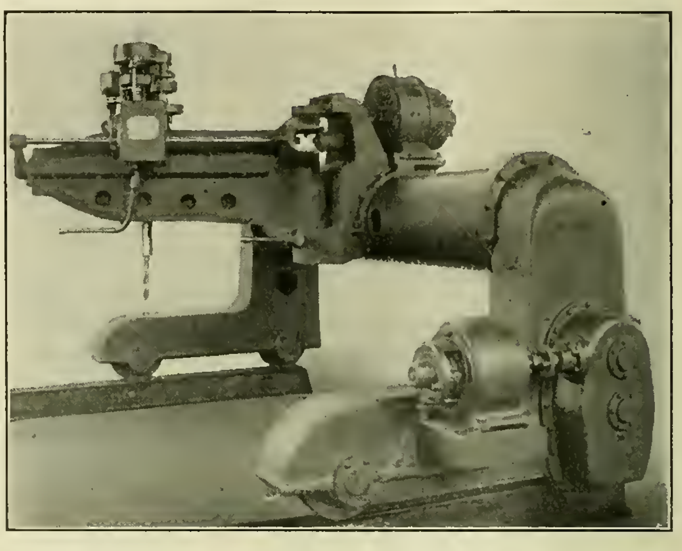
SOMETHING new in the line of drilling machines has been brought out recently by William K. Stamets, Pittsburgh, Pa., in the gantry drill illustrated. While this machine was designed and built for a tank car manufacturer it is obviously well suited for drilling holes in all kinds of steel plates and structural steel shapes and therefore adapted to use in boiler shops and steel fabricating plants. As shown in the illustration, the drill is mounted on a track the gage of which is wide enough to permit the drill to straddle any plates in which it is desired to drill holes. The span of the drill and the gage and length of track can be adapted to the requirements of the individual user.

The drill is a built-up structure mounted on four flanged wheels and arranged to be traversed back and forth on the track by means of a motor and adjustable controller shown at the right of the illustration. The motor is rigidly mounted on a bracket on the horizontal frame and connected through suitable reduction gears to one of the flanged wheels. As illustrated, these gears are amply guarded.

A drilling head is mounted on the radial arm, the latter being arranged to swing on its support on the cross-beam. The illustration shows only one radial arm and one drilling head but two, three or four arms and heads can be provided if desired. Two arms can readily be used on each side of the beams or if the span is increased, a larger number than four radial arms can be used. More than one drilling head can be mounted on each radial arm if so desired. In fact the entire arrangement is exceedingly flexible and can be adapted to meet the needs of any individual case.

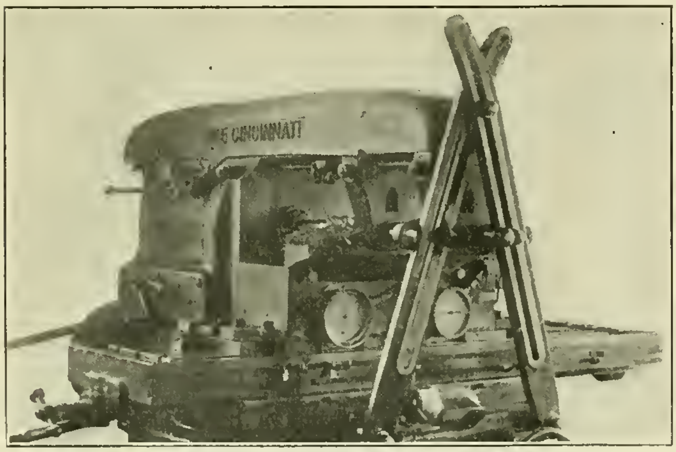
Motive power to drive the drill is supplied by means of the motor mounted on the beam. With direct current this can be an adjustable speed motor but with alternating current a multi-speed motor is used, permitting a wide range of speeds through the combination of the electrically controlled changes with the mechanical changes of the drill head. Owing to the widely varying requirements of manufacturers who would use this type of machine, no standard machine has been made but each is designed and built on a special order.

This gantry drill is adapted to the requirements of manufacturers of tanks, gondolas or other types of steel cars or in fact any product involving drilling holes in the centers of large plates, tanks, vessels or fabricated steel structures. Drilling, reaming and tapping operations can be performed as with the ordinary type of drill. The gantry drill is heavy enough to make clamping to the rails unnecessary and arrangement for clamping the radial arm has been provided by means of the lever indicated.


General View of New Gantry Drill

A Dynamometer for Milling Machines

WITH different combinations of feeds and speeds, the efficiency of the milling machine varies, and it is therefore important to have some means of determining the actual cutter pressures entirely independent of the efficiency of the machine or any part of its mechanism. For the accomplishment of this object, the Poliakoff dynamometer has been developed and placed on the market by the Cincinnati Milling Machine Company, Cincinnati, Ohio.


Pollakoff Dynamometer Applied to Milling Machine

The device provides means for reading the pressures exerted on any milling cutter while at work, in two directions, the readings being taken directly from the dials shown. A working table is provided, supported by a base plate which is in turn bolted to the table of the machine. The illustration shows the dynamometer in place on a No. 5 Cincinnati miller, taking a heavy cut in steel. The vertical downward or upward pressure of the cutter is read directly from the left hand dial and the longitudinal pressure of the cutter is read directly from the right hand dial. These are the pressures with which the designers and users of milling machines or milling cutters are most concerned. However, if it is also desired to obtain the crosswise pressure, i. e., the pressure in line with the milling machine arbor, the dynamometer can be mounted crosswise on the table.

In operation, a definite portion of the vertical load on the platen is carried to an hydraulic chamber placed centrally under the work table. This chamber is connected with the left hand gage which is graduated by trial in terms of the vertical load in pounds. The horizontal load is transmitted through bars, flexible vertically, to a crosshead which transmits the load to another hydraulic chamber placed between this crosshead and the end of the main frame of the dynamometer. This chamber is connected to the right hand gage by a pipe.

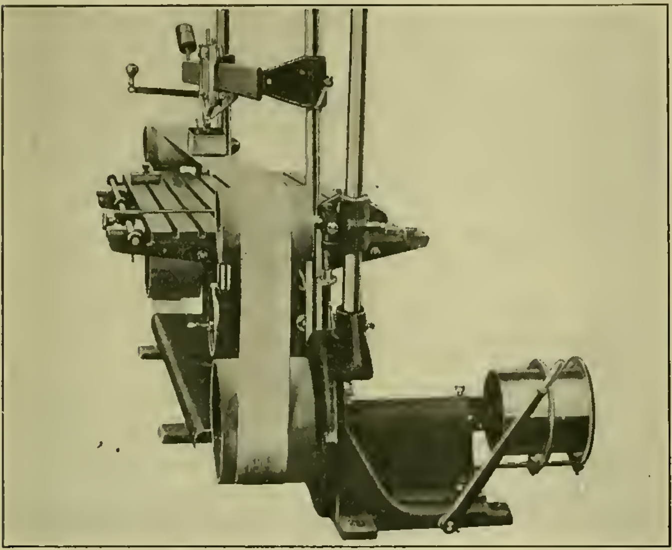
Heavy springs are used to put initial loads on each chamber so they will show loads in either direction. The fulcrums carrying the loads to the levers are so constructed as to be rigid against vertical and cross loads but flexible to longitudinal loads and the bars to the crossheads are flexible to vertical loads so neither system interferes with the action of the other. Guards are provided so that any desired lubrication or flooding of the cutter may be used.

The dynamometer has a capacity to withstand longitudinal loads of 25,000 lb. in one direction and 4,000 lb. in the opposite direction; vertical downward pressures of 10,000 lb. and upward pressures of 7,000 lb. The working surface of the working table is 16 in. long by 10 in. wide, and it is provided with three T-slots. The height of the working table above the bottom of the base is 8 in. The total size of the base of the dynamometer is 35 in. long by 14 in. wide.

The value of the dynamometer is evident for shops where milling operations are studied and given proper attention and the problems attending machines and cutter standardization can be more readily solved with its aid. Its use is not confined entirely to milling machines, but it is equally adaptable for making tests on planers, shapers, and with slight variations, drill presses.

Belt Sanding and Polishing Machine

Railroad car shop men will be interested in a new belt sanding and polishing machine recently put on the market by the Oliver Machinery Company, Grand Rapids, Mich. This machine, known as the Style 126 universal belt sander, has been designed for the rapid sanding and polishing of all kinds of line and edge moldings, flat and straight surfaces and for finishing built-up pieces. In railroad shops it should be adaptable to use in mill rooms and especially in pattern shops where it will save a large amount of hand finishing work.



Oliver No. 126 Universal Belt Sander

Speed of action, convenience of operation and safety are three important features claimed for this machine. It will be noted that the belt returns at the bottom under a suitable guard, thus eliminating the overhead belt and keeping all dust below the level of the operator's face. The belt runs down over the pulley, increasing the safety of the machine, preventing the breaking of sand from the belt and giving the belt a longer life. By means of a counter-shaft to take up the slack of the belt, a flexible tension to suit the work is maintained. The table rolls on ball bearings and runs easily so that a slight push will cause it to run the full travel of 36 in. The machine has a capacity to take work of any length and sand to the center of 72 in. It will take work on the table 54 in. high and over the floor 72 in. high. The table travels 36 in. with a vertical adjustment of 14 in. Sanding belts up to 10 in. wide may be used.

The table top is constructed of plain wood strips with 1-in. gaps between each strip. These gaps allow any dust that may accumulate to drop through, keeping the table top clean. The table is 32 in. wide by 96 in. long and is equipped with an adjustable bar to hold the work to be sanded. The idler is adjusted up or down to the height of the work and can also be adjusted in a tilting position to keep the sand belt from running to either side of the center. An edging attachment is made to apply to the power stand arm and is used for sanding edge work. It is composed of a belt plate adjustable table and can be raised or lowered at the will of the operator. It also has an attachment for sanding form edge moldings and irregular shapes.

The idler is adjustable up or down and is furnished with ball bearings. The machine is regularly equipped with a roller bearing countershaft for belt drive, or it may be arranged for motor drive if desired. The equipment consists of one sanding shoe, necessary wrenches and edging attachments. The machine is 80 in. high over all by 72 in. wide and weighs approximately 1,400 lb. It is arranged either with or without a sanding pad attachment according to the desires of the user.

Short-Turn Overhead Trolley System

Although the short-turn overhead trolley system, illustrated in Fig. 1, is comparatively a new departure, several successful installations have been made. The track consists of two parallel standard rolled channels, spaced 2⅛ in. between flanges and held in place by clamps. The track is designed to carry loads with no intermediate supports except at the splices, corners and switch points, and is fabricated to meet the requirements of each condition. One special feature of this system is that spanning a long gap, as from one building to another, can be done without intermediate supports by using a heavier section of channel.

The short-turn trolley system consists of the standard channels, 90-degree right switches, 90-degree left switches, 45-degree right switches, 45-degree left switches, and the universal switches. Each corner and switch connection is interchangeable so that at any time in the future a right corner can be removed and a double switch or universal switch bolted in the same place. The design and exceptional compactness of the short-turn universal switch gives much greater switching facilities and covers much greater space than any other switch.

All of the short-turn corners and switches have a track curvature of 18 in., practically turning the load at right angles. This is especially adaptable in foundries for serving a row of brass furnaces or machines close to the wall without losing valuable space by long sweeping curves. It is also a good feature in freight houses and terminals. This short-turn system can be extended out of the warehouse and along the receiving platform so as to load goods into an open freight car or automobile truck. The system can also be readily wired should an electric hoist be desired in place of chain falls. The track is built and shipped and can be erected as single units, thus greatly reducing the cost of erection.

Special 2-wheel, 4-wheel, or 8-wheel trolleys are provided, the 4-wheel type being illustrated in Fig. 2. There are ball-bearing wheels *W* and guide rollers *R* which run between the toes of the channels, practically eliminating friction and making it difficult for the wheels to bind against the track when rounding the curves. Carbonized steel ball bearings are shown at *B*, pivots at *P* and the hoist connection at *H*. The trolley runs on the level top of the channel tracks and is designed to swing in the same 18 in. radius curves. The fact that this track is built from standard rolled channels or can be built from I-beam sections where long spans and greater strength is required, makes it easy to obtain from local stocks and easier to erect. The operation of this system lightens the work and makes it much more easy and favorable for the workmen handling material, thereby decreasing labor turnover and increasing the efficiency of unskilled labor.

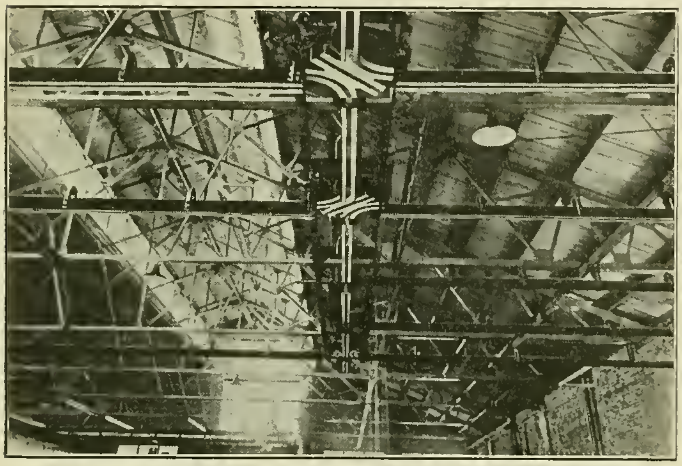


Fig. 1—View of Overhead Trolley System with Universal Switches

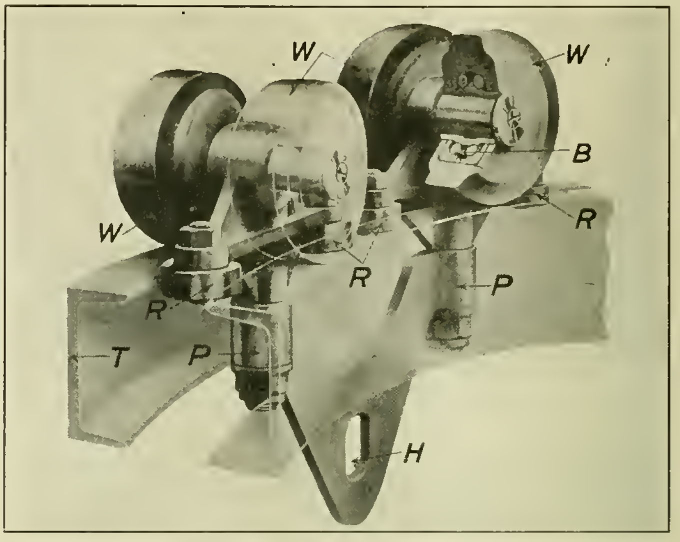
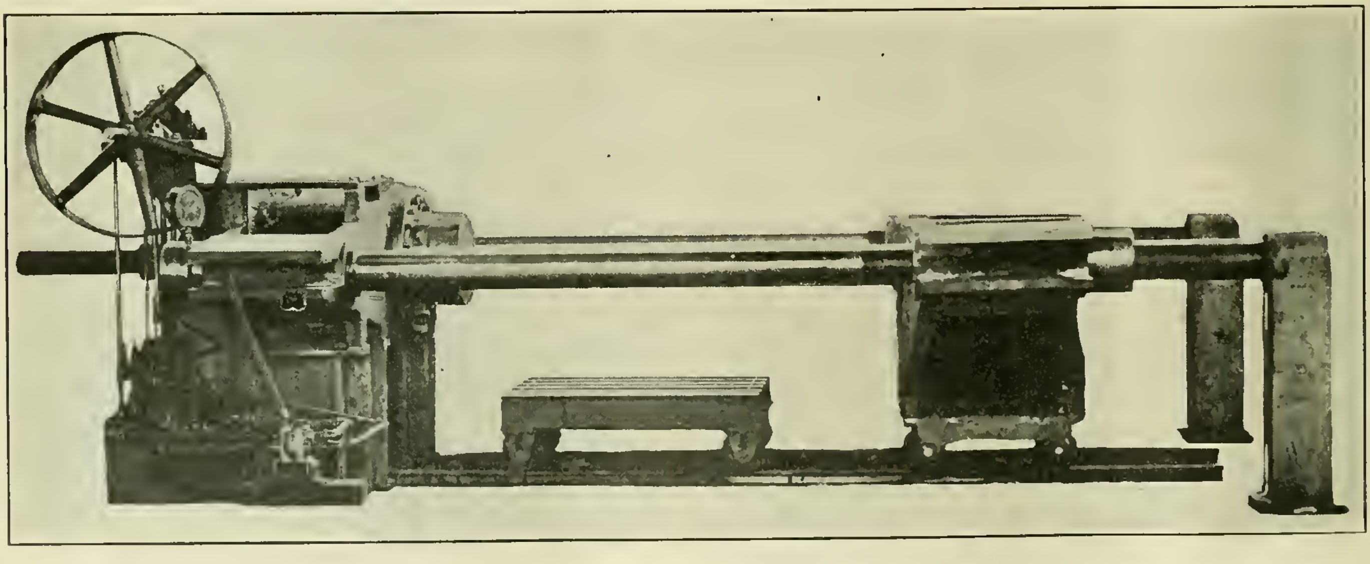


Fig. 2—Phantom View of Short Turn Trolley

The system is being manufactured and sold by the Whiting Corporation, Harvey, Ill.

Special Hydraulic Driving Wheel Press

The Hydraulic Press Manufacturing Company, Mount Gilead, Ohio, designed and built the special hydraulic press, illustrated, which was recently sold by the McCarter Cooper Company, New York, to the Compagnie General De Chemins De Fer & Tramways en Chine, Pekin, China. This press is used for forcing driving wheels on or off the crank-axles of locomotives, a special design of press being necessary because of the crank throws.


Hydraulic Press for Applying Driving Wheels to Crank Axles

The press will handle wheels 80 in. in diameter and less, being capable of exerting a force of 330 tons. The distance between strain bars is 84 in. and between ram and resistance head is 108 in. maximum. This may be decreased to 78 in. by moving the resistance head, which is mounted on wheels.

The press is also equipped with a belt-driven power attachment and three plunger pump with both low and high pressure plungers. The pump is equipped with hand and pressure knock-outs whereby any one or all pump cylinders may be eliminated from service at will or automatically when the maximum pressure is reached. A small hydraulic cylinder and ram returns the main ram to its starting position.

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WE GUARANTEE, that of this issue, 8,700 copies were printed; that of these 8,700 copies, 7,799 were mailed to regular paid subscribers, 8 were provided for counter and news company sales, 246 were mailed to advertisers, 8 were mailed to employees and correspondents, and 639 were provided for new subscriptions. samples, copies lost in the mail and office use: that the total copies printed this year to date were 85,050, an average of 9,450 copies a month.

The *Railway Mechanical Engineer* is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.)

The railways of Great Britain were returned to their owners on August 14 after having been under government control since the beginning of hostilities in 1914.

Operation of the Missouri & North Arkansas has been discontinued, following a long series of difficulties which culminated recently in a strike of the employees.

The Union Pacific shops at North Platte, Neb., have been reopened after being closed 7 months. Approximately 45 per cent of the former employees have been rehired.

The net railway operating income of the railways in June was $51,778,000, which was $14,697,346 more than in May. The figures are those of 202 Class 1 railroads operating 235,548 miles of line.

The Cleveland, Cincinnati, Chicago & St. Louis re-employed men laid off since last February at its shops at Bellefontaine, Ohio, on July 25. The Bellefontaine shops are now running at normal capacity.

An average on-time record of 92 per cent was made by the fast freight service of the Chicago, Indianapolis & Louisville, between Indianapolis, Louisville and Chicago, during the months of May and June.

The operation of freight trains on Sunday in the State of Georgia, which has been allowed since 1917 by the Railroad Commission as a war measure, must now be stopped, except in the case of perishable and live freight, the commission having on August 10 revoked the permissive order.

The Railroad Division of the American Society of Mechanical Engineers has elected the following Nominating Committee to present nominations for next year: G. M. Basford, G. M. Basford Company, chairman; W. L. Bean, N. Y., N. H. & H., and Kenneth Rushton, Baldwin Locomotive Works.

The New York, New Haven & Hartford announces that the Railway Clerks' Union has agreed to modification of the wage schedule regarding the payment of overtime and other compensatory rates, the new schedule to remain in force pending the decision of the United States Railroad Labor Board.

Differences in the cost of labor do not include changes in the quality or effectiveness of labor but only changes in wages, the Interstate Commerce Commission held in a decision handed down on August 6, prescribing the principles to be followed in fixing the maximum amount to be included in the carriers' accounts for operating expenses for maintenance during the guaranty period of six months following the termination of federal control on February 28 last year.

A 20 per cent wage reduction applying to all employees of the National Railways of Mexico earning 100 pesos or more a month went into effect on August 1. Following the refusal of the railway directorate to rescind this order for a wage cut, the organized employees issued an ultimatum threatening a general strike if the former scale of compensation was not continued.

In awarding contracts for the repair of 32,000 freight cars, figures prepared by the Lehigh Valley reveal that these contracts have been let at a saving of over $308,000 to the company, as compared with the cost of making these repairs in its own shops. This saving is made even in the face of the recent reduction in wages and is due to the rules and working conditions affecting costs in the railroad shops with which the outside contractors do not have to contend.

The Long Island Railroad has received from the United States Railroad Labor Board a decision to the effect that it must negotiate concerning rules with System Federation No. 90, affiliated with the Railway Employees' Department of the American Federation of Labor. The officers of the System Federation are all employees of the Pennsylvania Railroad. The officers of the Long Island declared they would deal only with their own employees, and the union took the case to the Labor Board.

The strike of the 302 members of the federated shop crafts on the Cincinnati, Indianapolis & Western, which started on July 22, because the railroad would not pay the men time and one-half for overtime, has been called off, and about half of the men have returned to work. They will be received by the company, however, as new men, having lost their seniority rights by their walk-out. B. A. Worthington, president of the road, states that the new men who were taken on to fill the positions of the strikers, will not be discharged to give room for the returning men.

As a result of the new system for the classification of cars for the expedition of trains through yards, the Baltimore & Ohio accomplished a saving of 61,167 engine hours during the month of June, 1921, as compared with June, 1920. Statistics on the relative number of cars handled during the month of June for the two years is not available for the entire system, but on the Eastern lines the number handled in June, 1920, was 522,113, as compared with 553,991 in June, 1921. The cars handled per engine hour were increased from 6.7 cars in June, 1920, to 8.5 cars in June, 1921, an increase of 27 per cent.

Frederick I. Cox, of New Jersey, was on July 22 nominated by the President as a member of the Interstate Commerce Commission in place of Edgar E. Clark, whose resignation took effect on August 31. The nomination was confirmed by the Senate on August 23. Mr. Cox was a silk salesman, for many years connected with Belding Brothers and Company, manufacturers, of New York City, and his appointment was made on the recommendation of the National Council of Traveling Men's Association, endorsed by Senator Frelinghuysen, of New Jersey. This association conducted a campaign in behalf of Mr. Cox last April, when the President made the appointments called for under the law enlarging the Commission. Mr. Cox was born on May 25, 1870, at Rockaway, N. J., and now resides at East Orange, N. J. He has been in mercantile pursuits throughout his business life. His appointment is for a term expiring on December 31, 1926.

Erie's Leases Marion Shops and Roundhouse

The Erie on August 15 announced that its local shops and roundhouse at Marion, Ohio, had been leased to the Railway Service Company of Marion, an organization of local manufacturers and capitalists, and that their operation by the new company would begin immediately. The announcement of the new plan was made by W. A. Baldwin, manager of the Ohio region of the Erie.

Mexican Locomotive Situation Improves

According to Assistant Trade Commissioner Cornell, 130 locomotives have been purchased in this country by the Mexican government. Of these, 85 were obtained on a rental basis with the view of ultimate purchase and 45 by outright purchase. On these cash payments of from 15 to 20 per cent have already been made. These purchases presumably do not include the recent purchase of 65 locomotives from the Baldwin Locomotive Works.

Anthracite Shipments in July

Shipments of anthracite in July are reported at 5,462,760 gross tons as compared with 6,031,937 tons in the preceding month, and 6,389,100 tons in July, 1920. There is a continued slack demand for pea and steam sizes, which has caused the closing down of a number of individual operations; and there has been considerable idleness from petty strikes in the Lehigh and Wyoming regions.

High Average of On Time Trains on the Pennsylvania

The Pennsylvania Railroad reports that in the Central Region on Tuesday, the 16th of August, 971 or 98.8 per cent of the 983 passenger trains operated in that territory arrived at their destinations on time and 982 trains or 99.9 per cent maintained schedule or better. The best previous daily record was made on July 25, when 99.7 per cent of the trains maintained schedule. In the month of July 98.9 per cent of the trains made schedule, an improvement of 3 per cent over July, 1920.

Electrification of the Victorian Railways

It is reported in the *Times* (London) Trade Supplement that the Victorian Railways Commissioners (Australia) are about to convert a further 100½ miles of their lines from steam to electric traction and that the work is to be completed by the end of February, 1923. In addition to this electrification, which covers the passenger carrying routes, a number of lines exclusively used for freight traffic are to be converted and the electric system extended over several of the busier sections of the country lines.

150 Cars, Eleven Miles an Hour

On August 7, the Ann Arbor Railroad ran what is said to be the longest freight train ever operated in the State of Michigan. It was from Owosso, Mich., southward to Toledo, Ohio, 104 miles. The train left Owosso at 6:15 a. m., with 53 loads and 97 empties, weighing 3,932 tons, and arrived at Toledo at 4:00 p. m., with 53 loads and 98 empties, weighing 3,951 tons. It was hauled by one locomotive of the Santa Fe type with 70,000-lb. tractive effort, equipped with duplex stokers, except that a pusher was used for four miles out of Owosso.

"Fuel Economy Month"

September has been designated as Fuel Economy Month by the Illinois Central and the campaign will apply to all departments using coal. The goal for the month has been set at 20 per cent less than the September record in former years. The best previous month's record in freight service was 133 lb. per 1,000 gross ton miles in June, 1918; in passenger service the best month's record was 1,637 lb. per 100 passenger car miles for August, 1916; while in switching service the best record was 117 lb. per switch engine mile in September, 1918. Weekly progress reports will be made by the divisional fuel committees.

D., L. & W. Electrification Bids Rejected

All bids for supplying electrical equipment for the Delaware, Lackawanna & Western's proposed electrification of some of its mileage in the Scranton, Pa., district have been rejected. July 29 was the last day upon which bids could be submitted. They were opened immediately and it was found that all were unsatisfactory. Gibbs & Hill, consulting engineers for the Lackawanna, who received the bids, may advertise for new offers soon. The General Electric Company and Westinghouse Electric & Manufacturing Company were the only two companies that submitted bids for furnishing the heavier equipment.

French Railway Places Order with Westinghouse

An order for electrical equipment amounting to $1,200,000 has been received by the Westinghouse Electric International Company from the Midi Railway of France. The order includes transformers, synchronous condensers, lightning arresters and other substation equipment. The Midi Railway operates an extensive system, starting from Bordeaux, running through Toulouse to Cette, with many branches. The section on which the Westinghouse equipment will be used extends from Pau to Toulouse in the Pyrenees mountains, near the Spanish border. The line passes through Tarbes and St. Gaudens, and has a total length of over 100 miles.

French Electrification Program

The huge electrification program, the execution of which is being seriously undertaken by the French steam railway lines, involves electrification within the next 15 years of approximately 6,000 miles of main lines mostly already double track and the building of hydro-electric plants and high tension transmission lines of the first magnitude. French engineers have gone so far as to promulgate a tentative program involving electrification of over 1,200 miles of main line per year and putting into service of not less than 400 new electric locomotives every year. Financial considerations will probably greatly curtail such a program, but the more conservative one of the electrification of 6,000 miles within fifteen years will involve buying between 200 and 300 new electric locomotives per year, which is a bigger project than has yet been undertaken in any other country.

Wood Preservers' Association Has Established Service Bureau

The American Wood Preservers' Association has established a service bureau to promote the use of treated timber and thereby conserve the forest resources of the country. This bureau is prepared to furnish information concerning the uses to which treated timber may be applied economically, to answer inquiries regarding the relative durability of treated and untreated woods, and to supply other data concerning the use of timber treated with the standard preservatives, such as zinc chloride and creosote. Headquarters have been established at 10 S. La Salle street, Chicago, and P. R. Hicks, engineer in forest products of the United States Forest Products Laboratory at Madison, Wis., has been appointed secretary-manager.

M. K. & T. Locomotive Makes Record Run

Missouri, Kansas & Texas locomotive No. 392, a coal burning Pacific type of 41,000 lb. tractive effort, recently made a continuous run of 1,024 miles, so far as is known the longest on record. The occasion was the movement of a special train of Shriners from Waco, Tex., to Kansas City, on the way to the Shriners' convention at Des Moines. The locomotive was suitably decorated at Denison, Tex., and ran light to Waco, where it was immediately turned and started on its trip on the Shriners' special. The average speed on the trip was 40 miles an hour. The engine was in perfect condition upon arrival at Kansas City, and because of its elaborate decorations it was desired to run it to Des Moines, but it was too heavy for the connecting line to handle.

Bad Order Cars

According to reports compiled by the Car Service Division of the American Railway Association, the number of bad order freight cars on July 1 totaled 354,661, or 15.4 per cent, as compared with 15.1 per cent on June 15. On July 15, cars in need of repair totaled 365,092, or 15.9 per cent of the cars on line, and on August 1 the bad order cars totaled 376,417, or 16.3 per cent.

Surplus Serviceable Cars

The average number of serviceable surplus freight cars for the first eight days of July, according to the reports compiled by the Car Service Division of the American Railway Association, was 369,525, a decrease of 4,266 cars as compared with the previous week.

An increase of 2,525 cars was shown for the week ended July 15, or a total of 372,050.

On July 23, the surplus cars numbered 350,772, a reduction of 21,278 cars when compared with the total on July 15.

On July 31, the cars totaled 321,781, a decrease of 28,991 cars when compared with the preceding week.

The total on August 8 was 297,784 serviceable cars, a decrease of 23,997 cars, as shown for the week ended July 31.

Wage Reductions in Canada

By a tentative agreement between the Railway Association of Canada and Division 4, Railway Employees' Department, American Federation of Labor, the railway employees in the locomotive and car departments, as specified in wage agreement No. 4, are now receiving a decrease of 8 cents per hour.

A similar agreement with United Brotherhood of Maintenance of Way Employees and Railway Shop Laborers has resulted in tentative reductions, as follows: All maintenance of way foremen and signal construction foremen, 80 cents per day; carpenters and other skilled workmen, 10 cents per hour; track laborers, crossing watchmen, bridge tenders and other laborers, 8½ cents; signal maintainers, 8 cents; signal helpers and helpers of maintenance mechanics, 7 cents; roundhouse laborers and ash pit men, 10 cents; pumpmen, $17.34 per month; signal men at interlocked crossings, $12.24.

Executives Decline to Comply With Brotherhoods' Requests

The Eastern Presidents' Conference at a meeting in New York on August 11 adopted the recommendation of its sub-committee that the executives reject the demands of the brotherhoods that the carriers restore wages to the level in effect on June 30 and pledge themselves against application for further reductions and against the elimination of time and a half pay for overtime. This was telegraphed to the leaders of the brotherhoods at Chicago. Executives in the Western, Southeastern and Southwestern regions rejected similar requests by the unions. It is understood that the New York decision was based upon the requirement of the transportation act that the railroads be managed in an economical and efficient manner; also to the fact that the 12 per cent wage reduction was effected on July 1 by the authorization of the United States Railroad Labor Board in decision No. 147, and that decision No. 119 of the board gave the carriers full authority to negotiate new working rules with their employees.

Freight Car Loading

The total number of revenue freight cars loaded for the week ended July 9, according to records compiled by the Car Service Division of the American Railway Association, was 639,698, a decrease of 156,493 cars as compared with the corresponding week last year, and of 170,147 cars as compared with the corresponding week in 1919.

The total for the week ended July 16 was 776,252 cars, an increase of 136,554 cars over the preceding week when, however, the observance of Fourth of July resulted in a drop in the total. 166,599 cars more were loaded during the corresponding week in 1920, which was 126,044 cars less than were loaded during the corresponding week in 1919.

During the week ended July 23, 790,348 freight cars were loaded. This was an increase of 14,096 cars over the preceding week, but was, however, a decrease of 138,070 cars when compared with the corresponding week of 1920, and a decrease of 119.334 when compared with the corresponding week of 1919.

796,570 cars was the total loaded for the week ended July 30, an increase of 6,222 cars over the week ended July 23. During the corresponding weeks of 1919 and 1920, 925,195 and 936,366 cars, respectively, were loaded.

A total of 784,781 cars loaded with revenue freight was shown in the association's report for August 6. This was a decrease of 11,789 when compared with the preceding week; a decrease of 87,292 and 150,947 when compared with the corresponding weeks of 1919 and 1920.

Locomotives

The Imperial Government of Japan has ordered, through Takata & Company, New York, 2 electric freight locomotives from the Westinghouse Electric International Company. The locomotives will weigh 62 tons and will have 1,000 h.p. capacity.

The National Railways of Mexico have ordered from the Baldwin Locomotive Works, 10 Pacific type locomotives, 15 Mikado, 20 Consolidated and 20 narrow-gage.

Freight Cars

The Katanga Railway (Africa) has placed orders with Belgian car builders for 60 gondola cars.

The Russian Soviet Government, according to a dispatch from Montreal, Que., has given the Canadian Car & Foundry Company, Ltd., a $2,000,000 order for 500 50-ton tank cars.

The Atlantic Fruit Company, New York, has ordered 100 cane cars of 20-ton capacity from the Magor Car Company.

Shop Construction

Atchison, Topeka & Santa Fe.—This company has awarded a contract to E. F. Ware, El Paso, Tex., for additions to its power house at Albuquerque, N. M., to cost approximately $150,000.

Chicago, Rock Island & Pacific.—This company will construct a new car repair shop at Trenton, Mo., with company forces.

Chicago, Rock Island & Pacific.—This company has awarded a contract to Joseph E. Nelson & Sons, Chicago, for the construction of an 8-stall roundhouse at Amarillo, Tex. The building will have brick walls and a timber frame and roof, and is estimated to cost about $35,000.

Illinois Central.—This company has awarded a contract to G. A. Johnson & Son, Chicago, for the construction of a frame enginehouse, with dimensions of 60 ft. by 200 ft., at Herrin, Ill.

Missouri Pacific.—This company has awarded a contract to Joseph E. Nelson & Sons, Chicago, for the construction of 5 car-repair sheds. These sheds will be of frame construction, 40 ft. wide by 240 ft. long, and will be built at Crane, Mo., Council Bluff, Sedalia, Jefferson City and Nevada. The total cost of this work is estimated at about $55,000.

Contracts for Car Repairs

The Georgia Railway is making repairs to 125 box cars, in its shops at Augusta.

The Lehigh & New England is having repairs made to 300 box cars at the shops of the Middletown Car Company, Middletown, Pa.

The Erie has given a contract to the Illinois Car Company, Urbana, Ohio, for the repair of 400 40-ton box cars.

The Virginian Railway is having repairs made to 150 hopper cars, of 50-ton capacity, at the shops of the Virginia Bridge & Iron Company.

The Central of Georgia is having repairs made to 200 box cars, in its own shops.

The Atlantic Coast Line is having repairs made to 350 box cars, in its own shops.

The Pittsburgh & West Virginia is having repairs made to 300 hopper cars at the shops of the Koppel Car Repair Company, Koppel, Pa.

The Erie has entered into a contract with the Greenville Steel Car Company, Greenville, Pa., for the repair of 500 coal cars, of 50 tons capacity.

The Delaware, Lackawanna & Western has given contracts for the repair of box cars to the Magor Car Company for 500, to the Buffalo Steel Car Company 500, and the American Car & Foundry Company 500.

Buffalo, Rochester & Pittsburgh will make repairs to a total of 2,000 30-ton wooden box cars. The company has given a contract to the Buffalo Steel Car Company for repairs to 500, 50-ton hopper cars and is having repairs made to 500 box cars in its own shops at Du Bois, Pa.

The New York Central has given contracts for the repair of freight cars as follows: For the New York Central, 500 box cars to the Ryan Car Company; 500 box cars to Streator Car Company; 500 box cars to Standard Steel Car Company; 500 hopper cars to American Car & Foundry Company, and 500 hopper cars to Buffalo Steel Car Company. For the Pittsburgh & Lake Erie, 500 box cars to Pressed Steel Car Company, 1,000 hopper cars to Standard Steel Car Company, and 500 gondola cars to the Youngstown Steel Car Company. For the Cleveland, Cincinnati, Chicago & St. Louis, 500 general service cars and 500 hopper cars to American Car & Foundry Company. For the Michigan Central, 500 box cars to the Illinois Car & Manufacturing Company, and for the Lake Erie & Western, 500 box cars to Haskell & Barker Car Company.

The Lehigh Valley has awarded contracts for the repair of equipment, as follows: American Car & Foundry Company, 1,000 box cars; Magor Car Corporation, 1,000 box cars; Buffalo Steel Car Company, 500 steel coal cars; American Car & Foundry Company, 500 steel coal cars; Lehigh Structural Steel Company, 200 steel coal cars.

The Chicago Great Western is having repairs made to 198 box cars, at the shops of the Ryan Car Company, Chicago.

MEETINGS AND CONVENTIONS

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

Division V—Equipment Painting Division.—V. R. Hawthorne, Chicago.

American Railway Association, Division VI—Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamlin Ave., Chicago. Convention September 12-14, Hotel Sherman, Chicago, Ill.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Society for Steel Treating.—W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention September 19-24, Indianapolis, Ind.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Next meeting September 13, Windsor Hotel, Montreal. Paper on "Train Operation by Telegraph vs. Telephone," by W. J. Camp, asst. mgr. C. P. R. Telegraphs.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Meeting second Monday in month, except June, July and August, New Morrison Hotel, Chicago, Ill.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y.

Chief Interchange Car Inspectors and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Meeting second Tuesday of February, May, September and November, at Hotel Sinton, Cincinnati.

Dixie Air Brake Club.—E. F. O'Connor, 10 West Grace St., Richmond, Va.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 715 Clarke Ave., Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn.

Master Boilermakers' Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Meeting second Tuesday of each month, except June, July, August and September.

New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Meeting second Friday of each month, except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Next meeting September 19. Paper on "A Shipper's View of the Evolution of Transportation and Its Effect on Steam Railways," by George C. Conn, director of traffic of the Buick Motor Co. Buffet luncheon following.

PERSONAL MENTION

GENERAL

M. McKernan has been appointed superintendent of safety of the Missiouri Pacific, with headquarters at St. Louis, Mo., succeeding R. H. Dwyer, who has been assigned to other duties.

E. J. Brennan has been appointed superintendent of motive power of the Chicago Great Western, with headquarters at Oelwein, Iowa, effective August 15, succeeding H. C. Eich, resigned.

G. C. Seidel, master mechanic of the Minneapolis & St. Louis, with headquarters at Marshalltown, Iowa, has been appointed mechanical engineer of the Chicago & Alton, with headquarters at Bloomington, Ill., effective August 13, succeeding J. H. Leyonmarck, deceased.


James I. Mailer

James I. Mailer, whose promotion to superintendent of motive power of the Fort Smith & Western, with headquarters at Fort Smith, Ark., was announced in the August issue of the *Railway Mechanical Engineer*, was born at Alma, Wis., on April 24, 1877, and entered railroad service in December, 1893, on the Winona & Western. In 1897, he was employed by the Chicago Great Western as a machinist where he served until 1899, when he went with the Great Northern as a fireman. In 1900, after firing on the Northern Pacific and Southern Pacific he returned to the Chicago Great Western as shop foreman. A year later he was appointed general foreman of the Minnesota North Wisconsin where he served until 1904. Mr. Mailer has been in the service of the Fort Smith & Western continuously since 1904. From 1904 to 1906 he served as general foreman at Fort Smith, and from 1906 until January 1, 1921, he was employed as an engineman. On the latter date he was promoted to master mechanic and was serving in this position at the time of his recent promotion.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

G. L. Ernstrom has been appointed road foreman of engines of the Yellowstone division of the Northern Pacific.

T. Allison has been appointed road foreman of engines of the Pasco division of the Northern Pacific, with headquarters at Pasco, Wash., effective August 17, succeeding R. E. Wilkinson, who has been granted an extended leave of absence.

SHOP AND ENGINEHOUSE

M. J. Manion has been appointed roundhouse foreman of the Chicago, Rock Island & Pacific at Pratt, Kans.

R. E. Detrick has been appointed roundhouse foreman of the Chicago, Rock Island & Pacific at El Reno, Okla.

H. Schmidt has been appointed roundhouse foreman of the Erie Railroad, at Cleveland, Ohio, succeeding E. Vlk.

CAR DEPARTMENT

J. R. Sanderstrom has been appointed assistant car foreman of the Chicago, Rock Island & Pacific at Herington, Kans.

PURCHASING AND STORES

C. C. Kyle has been appointed acting general storekeeper of the Northern Pacific, with headquarters at St. Paul, Minn., effective August 17, succeeding O. C. Wakefield.

R. H. Johnson, general manager and purchasing agent of the Peoria & Pekin Union, with headquarters at Peoria, Ill., has resigned and the purchasing department has been placed under the jurisdiction of the president's office.

H. S. Burr, general superintendent of stores of the Erie with headquarters at New York, has been appointed assistant to the manager of stores with the same headquarters. C. K. Reasor has been appointed to a similar position with the same headquarters. The positions of general superintendent of stores and assistant general superintendent of stores have been abolished.

Gordon Thomas has been appointed division storekeeper of the Wyoming division of the Lehigh Valley at Coxton, Pa., succeeding P. H. Shay, resigned. C. J. Roesch has been appointed division storekeeper of the M. & H. division at Stockton, Pa., succeeding Mr. Thomas. W. J. McKaig has been appointed division storekeeper of the New York division, with headquarters at Jersey City, N. J., succeeding Mr. Roesch.

OBITUARY

M. Flanagan, general master mechanic on the eastern district of the Great Northern died at St. Paul, Minn., on August 2.

J. H. Leyonmarck, mechanical engineer of the Chicago & Alton with headquarters at Bloomington, Ill., died at his home in that city on August 1.

F. F. Gaines

F. F. Gaines, formerly superintendent of motive power of the Central of Georgia, died at Washington, D. C., on August 26. Mr. Gaines was born on March 28, 1871, at Hawley, Pa. He entered railway service in 1888 as a freight and ticket clerk for the Erie. Two years later he resigned to enter Cornell University, at which institution he studied for the following four years. Upon leaving the university he served in the shops of the Erie for a time and in August, 1895, became a draughtsman for the Lehigh Valley and the following year was appointed engineer of tests. In April, 1897, he was promoted to mechanical engineer and in November, 1902, was appointed master mechanic. Two years later Mr. Gaines became mechanical engineer of the Philadelphia & Reading and in 1906 he went to the Central of Georgia as superintendent of motive power. In 1917 Mr. Gaines resigned as superintendent of motive power on account of ill-health but continued in the service of the company. In July, 1918, he was appointed a member of the committee of standards of the Railroad Administration and the following year was elected chairman of the Board of Wages and Working Conditions. He subsequently served as a member of Railway Board of Adjustment No. 3. Mr. Gaines was well known for his work in improving combustion and was the inventor of the Gaines locomotive furnace. He served as president of the Master Mechanics' Association for the year 1914-1915.

The Chicago, Rock Island & Pacific has created a new department of personnel and public relations under the supervision of H. S. Ray, assistant to the president. Mr. Ray will be especially concerned with the maintenance of cordial relations between the management and the employees.

SUPPLY TRADE NOTES

The Barrett Company on August 1 removed its offices from 17 Battery Place to 40 Rector street, New York City.

The Tuco Products Corporation, New York, has opened an agency at Spokane, Wash., in charge of L. J. McNally.

The O. M. Edwards Company, Inc., Syracuse, N. Y., has moved its Chicago, Ill., office to 532 First National Bank building.

F. C. Severin, New York manager, with office at 50 Church street, of the Betts Machine Company, Rochester, N. Y., has resigned to go into other business.

LeRoy Kramer

The T. H. Symington Company, New York, has created a new Northwestern district for the selling of its products. J. F. Schurch, vice-president of this company, and also president of the Railway Supply Manufacturers' Association, who has been in charge of the Symington office at Chicago for several years, is in charge of this district with headquarters in St. Paul, Minn. The Chicago office is in charge of Le Roy Kramer who has been elected vice-president and director of the company. He assumed his new duties on August 1. Mr. Kramer spent many years in the operating departments of the St. Louis-San Francisco and the Rock Island railroads and for six years was vice-president in charge of manufacturing for the Pullman Company. During the war he acted as federal manager of the St. Louis-San Francisco and the Missouri, Kansas & Texas railroads at St. Louis under the United States Railroad Administration. He left there in the Spring of 1919 to become vice-president in charge of production for the Willys-Overland plant at Toledo, and was also for a time vice-president of the Pierce-Arrow Company at Buffalo.

A. Clarke Morre has resigned as assistant to president of the Globe Seamless Tube Company, with which he has been connected since November, 1919.

John Duncan, vice-president of the Wheeling Steel Products Company, Wheeling, W. Va., has resigned to engage in the operation of coal, coke, iron ore and railroad properties in Illinois.

The Glidden Company, Cleveland, O., and its affiliated companies have been given the manufacturing and distributing rights, in North America, for the Holland enamel paint known as Ripolin.

Stewart C. Wilson has been appointed Pittsburgh district sales manager of the Whiting Corporation, Chicago, succeeding Robert S. Hammond, who has been transferred to the Chicago office.

E. A. Woodworth, formerly with the Imperial Belting Company, Chicago, as railroad representative, has left the service of that company to take charge of the southwestern territory for the United States Metallic Packing Company, Philadelphia, Pa., with headquarters in Chicago.

L. M. Waite, formerly sales manager of the National Acme Company, Cleveland, Ohio, and later sales manager of the Springfield Automatic Screw Machine Company, Fitchburg, Mass., has been appointed sales manager of the Garvin Machine Company, New York, succeeding Frank A. Power, resigned.

TRADE PUBLICATIONS

Thread Micrometer.—The Bath internal thread micrometer and master ring are illustrated and described in Bulletin No. 20, a 4-page leaflet issued by John Bath & Co., Inc., Worcester, Mass.

Thread Cutting Tools and Machines.—The Geometric Tool Company, New Haven, Conn., has issued a booklet of 20 pages illustrating its line of screw thread cutting tools and machines.

Cranes.—Typical illustrations of a line of Northern bucket cranes in actual operation are shown in Bulletin No. 520-B, recently issued by the Northern Engineering Works, Detroit, Mich.

Sharon Standards.—An illustrated catalogue of 8 pages intended to give some idea of its resources and facilities for handling pressed steel requirements, has recently been issued by the Sharon Pressed Steel Company, Sharon, Pa.

Valves.—An unusual set of 12 circulars, in each of which a particular line of valves suitable for various steam pressures is briefly outlined and illustrated, has recently been issued by the Walworth Manufacturing Company, Boston, Mass.

Powdered Coal.—Two booklets on the Use of Pulverized Coal Under Central Station Boilers, by John Anderson, and Powdered Coal Application to Four 2,640 H.P. Boilers, by H. D. Savage, are being distributed by the Combustion Engineering Corporation, New York.

Signaling Systems.—Some of the products manufactured by the Holtzer-Cabot Electric Company, Boston, Mass., including fire-alarm systems, calling systems, watchmen's clock systems, etc., are briefly described in a 14-page, illustrated booklet which the company has recently issued.

Valves.—The ease with which worn parts may be removed and replaced in "Flatplug" valves, which have been designed to meet the need for tight valves in varied uses and for working pressures up to 175 lb., is explained and pictured in an interesting folder recently issued by the Everlasting Valve Company, Jersey City, N. J.

Truck Bearings.—The advantages and methods of installation of Hyatt bearings for trucks of all kinds are outlined in the first few pages of a 16-page report recently issued by the Hyatt Roller Bearing Company, New York. The remaining pages contain a number of clear-cut illustrations of Hyatt equipped trucks made by leading manufacturers.

Chucks.—Prices and code words for the different styles of chucks manufactured by the Cushman Chuck Company, Hartford, Conn., are listed in a 16-page illustrated booklet which the company has recently issued. The booklet is neatly arranged and has an outside cover of transparent celluloid to which a small blotter is attached.

Steam Jet Ash Conveyors.—The Conveyors Corporation of America, Chicago, has recently issued a booklet entitled "The Proof of the Pudding," which contains reproductions of 70 letters regarding the service obtained with American steam ash conveyors. The list of users who commend this device includes several prominent railroads.

Welding and Cutting Apparatus.—Condensed statements of range and adaptation of Rego cutting and welding apparatus are given in Catalogue No. 23 recently issued by the Bastian-Blessing Company, Chicago. The catalogue is an attractive, well-arranged treatise of 40 pages and contains in addition to illustrations of the different types of equipment and prices, data on torch pressures and consumption.

Small Tools.—A new and comprehensive catalogue describing small tools, including screw plates, taps, dies, drills, reamers, milling cutters, bits, tap and pipe wrenches, pipe vises, etc., which comprise the greater part of its product, has recently been issued by the Greenfield Tap & Die Corporation, Greenfield, Mass. A great deal of information of interest to the user and designer of tools and machinery and some especially instructive tables are also contained therein.

Locomotive Stokers.—The first ten pages of an attractive booklet of 14 pages recently issued by the Locomotive Stoker Company, Pittsburgh, Pa., are devoted to a description of the Duplex stoker and contain clear-cut illustrations which show details of its construction and operation. The remaining pages outline the organization behind the Duplex stoker and include a list of both foreign and domestic railroads using this device.

Pneumatic Tool Accessories.—Air hose, hose couplings, hose clamps, drill chucks, rivet sets and blanks, wire brushes, oils and greases, rail drills, and other accessories for use in connection with Little David pneumatic tools are described and illustrated in Bulletin Form No. 8017, recently issued by the Ingersoll-Rand Company, New York Tables of dimensions of all rivet sets and chisels are also included.

Packings.—A catalogue, presenting its full line of packings, gaskets and pump valves, is one of the recent publications of the United States Rubber Company, New York. It is fully illustrated and contains definite information regarding each item listed and the specific uses for which it is best fitted, also detailed drawings of construction. A classified index of the different styles of packings sets forth the packings which are recommended for the various conditions of service.

Real Production Tools.—Under the title of "Real Production Tools" the Goddard & Goddard Company, Inc., Detroit, Mich., is distributing a series of pamphlets illustrating and describing some of the tools manufactured by that company. The pamphlets are intended to be largely educational, indicating the lines along which increased production and more accurate work can be obtained in machine shops. The first pamphlet of the series is devoted to the half side mill. The advantages of this form of milling cutter are explained particularly as compared to the standard type side mill with cutting edges on both sides.

Starrett Tools.—A new catalogue that has been issued by the L. S. Starrett Company, Athol, Mass., is not only an improvement in appearance and arrangement over previous catalogues, but contains information about twenty-one new tools. Among the features of especial interest may be mentioned an improvement in the Starrett universal bevel protractor, No. 359; a new No. 24A micrometer caliper gage; new micrometer calipers graduated in millimeters; a new metric fillet or radium gage; a new set (No. 278) of accurate V-clocks and clamps, and a new pair of Starrett firm joint dividers (No. 139).

Freight Cars and Appliances.—The Canadian Car & Foundry Co., Ltd., Montreal, Canada, has recently issued a series of bulletins describing cars built by the company and some of the specialties manufactured in its plant. The numbers of the bulletins and the subjects are as follows: No. 11, Simplex safety brake head; No. 12, A. R. A. standard D coupler; No. 21, box cars for the Canadian Pacific; No. 22, box cars for the Canadian National Railways; No. 23, composite underframe refrigerator cars for the Canadian National; No. 24, all wood stock cars for the Canadian National; No. 31, cars for foreign service.

Wood Construction Information Service.—The National Lumber Manufacturers' Association, Chicago, has recently issued some additional data dealing with mill construction. The subjects treated in these sheets deal with basement floors, roof and roof coverings and include a set of floor beam charts to facilitate the determination of the most economical system of floor construction to carry a given load. Another subject presented is a progress report of tests made by the Forest Products Laboratory, Madison, Wis., in co-operation with the association on built-up beams under various loads in comparison with solid timbers.

Cylinder Regrinding.—A comprehensive, 116-page booklet on "Cylinder Regrinding" has been issued recently by the Heald Machine Company, Worcester, Mass. While this booklet is intended primarily to "assist those entering the business of regrinding automobile cylinders" the cylinder grinding machine illustrated is adapted to many grinding operations in railroad shops. The construction of the machine and many of its possible uses are plainly indicated. There are also several pages of interest to railroad men in showing the advantages of grinding as compared to reaming cylinders. The old idea that abrasive adheres to ground metallic surfaces is shown to be erroneous. The last few pages of the booklet are devoted to special Heald machines including the Styles 80, 85, 70 and 75 internal grinders, the unusually massive cylinder grinder No. 65 and the surface grinder No. 20-22. Heald magnetic chucks are illustrated and described on the last page of the booklet.

Railway Mechanical Engineer

Volume 95 October, 1921 No. 10

CONTENTS

EDITORIAL:
- Mechanical Associations on the Defensive ... 605
- Suggestions on the Purchase of Machine Tools ... 606
- What Constitutes the Cost of Shop Work? ... 606
- Encourage the Man Down the Line ... 607
- A Brighter Outlook for Car Repairs ... 607

COMMUNICATIONS:
- Insulation of Freight and Passenger Cars ... 608

GENERAL:
- New Locomotives for the Missouri Pacific ... 609
- Long Stroke Cylinder Tests on Southern Pacific ... 613
- Informal Meeting of Traveling Engineers ... 614
- The Effect of the Feed Water Heater on Superheat and Back Pressure 619
- The Comparison of Dimensions and Proportions of British Locomotives ... 621
- Recent Developments in the Storage of Coal ... 626

CAR DEPARTMENT:
- 100-Ton Coal Cars for the Chesapeake & Ohio ... 627
- The Railroad Shop vs. the Contract Shop ... 631
- Bad Order Cars Reached Maximum in August ... 635
- Thawing Frozen Hopper Cars ... 638

SHOP PRACTICE:
- Successful Methods Used in Repairing Side Rods ... 639
- Malleable Castings Improved by Research ... 643
- Feed Valve Testing Device ... 644
- Steel Treaters Meet at Indianapolis ... 645
- The Effect of Temperature in Case-Hardening ... 648
- Wheel Lathe Tool-Holders for Use with High Speed Steel Tool Bits 651

NEW DEVICES:
- Heavy Car Wheel Boring Machine ... 653
- An Alloy for High Temperature Castings ... 654
- Rotary Turret Shear of Large Capacity ... 655
- Combination Hardness Testing Machine ... 656
- Boring, Drilling and Milling Machine ... 657
- Locomotive Driving Wheel Quartering Gage ... 658
- Oil-Pressure Transmission and Feed Control ... 659
- Combination Fibre and Metallic Packing ... 660
- A New Precision Machine Alining Level ... 660

GENERAL NEWS:
- Notes ... 661
- Meetings and Conventions ... 666
- Personal Mention ... 666
- Supply Trade Notes ... 667

Mechanical Associations on the Defensive

Men and institutions in or related to railroad work have been on trial during the past year as they have probably never been on trial before in the history of railway transportation. As one of the results of the world war there has been created a general state of mind which not only is exceedingly critical of all existing institutions but which is even inclined to assume that the burden of proof lies with those who would defend them. Technical associations of railway officers and supervisors, particularly in the mechanical department, have not escaped this situation, and developments during the past year have added tremendous force to this questioning of values and of the right to continued existence.

Most of these associations have become closely affiliated with organizations of supply companies whose interests in the various fields of association work have led them to place their products on exhibit during the annual conventions. These exhibits have undoubtedly been of great mutual benefit. The unprecedented conditions in the railway market for the past two years, however, have been such that the assembling of these exhibits did not seem justified this year. Following the decisions to that effect, there immediately began a movement among the railroad associations to postpone their conventions, which culminated in the resolution passed by the Association of Railway Executives recommending the general adoption of that policy by all organizations within its control. This action has raised several questions on the answer to which the future of these associations may depend.

First, if these organizations are of any value to the railroads in developing a deeper interest in better railroading and in improving practices, why was not their work most needed by the roads in the present period of stress? The abandonment of this work at such a time certainly implies a lack of confidence in their value, by their members as well as by the railway executives.

Second, are exhibits of tools and equipment and the support of the exhibiting organizations the prime object of these conventions? Recent events, taken at their face value, suggest an affirmative answer to this question.

Third, if the answer to the second question is "Yes," are the railroads justified in encouraging the continuance of these conventions, even after a return of prosperity? There is no escape from the conclusion that the roads ultimately must bear the expense of these exhibits, as well as part of the expense of the conventions themselves.

The *Railway Mechanical Engineer* believes that the work of these associations should be continued. But if it is to be continued the purpose and the return expected should be clearly formulated in the minds, both of the association members and of the executives who direct the policy of the railroads. There were sufficient exceptions to the general rule of conduct this year to prove that a successful convention could be held even under the present unfavorable conditions. The International Railway Fuel Association convention was well attended and the work done fully justifies the course taken by the executive committee. Furthermore, its success was not in spite of, but partially because of railroad support. The Traveling Engineers' Association, in a half-hearted attempt to evade responsibility, held a meeting the nature of the work at which would have fully justified the executive committee had it called a full-fledged convention. The influence of the latter would have been felt with much greater force than was possible with the small attendance which the call for the meeting brought out.

The responsibility for the success of these associations lies primarily with the membership. Unless the members are thoroughly convinced of the value of their organization and are willing to back that conviction by their actions, how can they expect to win, even half-hearted support from railway managements? The time is ripe for some clear thinking on this subject by railway association members. This should result in well defined conclusions. When those conclusions have been arrived at they should be backed up with all the concerted force of which the membership is capable.

Suggestions on the Purchase of Machine Tools

Limited numbers of machine tools have been purchased by the railroads in the past few weeks, and it is reasonable to suppose that, in view of the need for modern shop equipment and the gradual improvement in the financial situation, still more orders for machinery will be placed in the near future. It is not amiss at this time, therefore, to consider several suggestions on the purchase of machine tool equipment, suggestions demonstrated by experience to be of prime importance, not only to the railroads but to the manufacturers as well.

The false economy of purchasing on a price basis only has been pointed out many times in the *Railway Mechanical Engineer* and most railroad men realize that such a policy can well be characterized as "penny wise and pound foolish." Mechanical department men responsible for shop output are in a position to know, if anyone does, just what machines are needed, and if the financial condition of a road does not warrant the purchase of the specific machines requested, it would be better to postpone buying rather than get cheaper substitutes which do not fill the need.

Another undesirable practice, followed perhaps unavoidably on some roads, is the buying of a large order of machine tools at one time, and not ordering again for two or three years. It would be much better wherever possible to replace each machine as it becomes too worn, or out of date, for economical use, and no difficulty will be found in financing these replacements provided adequate depreciation accounts are maintained. These are two main arguments in favor of replacing machinery as it becomes worn out and thus incidentally distributing orders throughout the year. From the point of view of railroad men the sooner obsolete machines are replaced the sooner is efficient shop operation secured. From the manufacturer's viewpoint, the distribution of orders throughout the year will enable him to employ a medium force of men in a shop of medium capacity all the year round. The result will be a reduced cost to the manufacturer who can sell machines for less money while making the same profit.

A third practice to be recommended in the purchase of machine tools is to hold up requests for bids until there is at least a reasonably good prospect of immediate purchase. In a certain case, bids were asked for 18 months before the order was placed and in an endeavor to close the order a representative of the manufacturer made a trip to the shop immediately. Several subsequent trips were made in the 18 months and eventually all profit from the sale went to pay for the salesmen's time and traveling expenses. It is obvious that if this practice were followed extensively, the manufacturer would soon be compelled to charge more for machines to offset the additional selling cost. But the objection may be raised that it is often necessary to ask for prices and data far ahead of possible orders so as to determine the advisability of installing certain machines. This difficulty can be readily overcome by stating on the request that the bids are required for purposes of preliminary estimate only.

It may not be entirely clear why railroad men should care if machine tool manufacturers are put to unnecessary expense, and the answer is that whatever represents an economic loss to one branch of industry is harmful to the entire country. The position of the United States as the leading industrial nation is due in no small measure to the enterprise, foresight and persistent effort of manufacturers who design and build time and labor saving machinery. For their mutual advantage, railroad men should co-operate in every possible way with machine tool manufacturers so that the latter will be able to furnish machinery at the lowest cost consistent with good material, careful workmanship and a reasonable profit.

What Constitutes the Cost of Shop Work?

It is an unfortunate fact that the word "cost" conveys various meanings to different people. A failure to recognize its full significance has been the cause of much fruitless discussion, has resulted in many a false decision and has brought failure to multitudes of promising enterprises. Through many hard knocks and in accordance with the law of the survival of the fittest, the successful manufacturer or merchant has learned that the cost of an enterprise includes far more than the expenditures for labor and materials. In the years which are now little more than a tradition, the shrewd manager was often able to carry on a business successfully for a long time without a full knowledge of the various factors which made up his manufacturing costs. His business sense led him to recognize their existence in a general way and thanks in a large measure to the lack of severe competition, he was able to add a sufficient amount to his direct costs to ensure a profit after meeting all incidental obligations. If he guessed too low in one case, his next guess may have been sufficiently high to offset the loss. If he failed frequently to make a sufficient allowance for overhead, the result was bankruptcy and the courts distributed what was left among the creditors.

The natural evolution was the development of an accurate cost accounting system which would not only take care of and properly distribute the burden for indirect labor, power, lights, general materials and supplies, but also such obscured, though nevertheless vital, factors as insurance, taxes, maintenance, depreciation, betterments, replacements, procuring of capital, sales expenses, provision for periods of low production, losses, unforeseen contingencies, etc. The development during the last 20 years of industrial cost accounting methods is one of the striking features in connection with our large manufacturing organizations. Accounting has been developed to a high degree. As a result managers now base their decisions in regard to provision of manufacturing facilities, what shall be made, the character and quality of the product and even the entire selling campaign upon the bed rock of accurate cost accounts.

When we turn from the manufacturing to the railroad field, the contrast in cost accounting is a startling one. As the function of a railroad is to provide transportation and the maintenance of its rolling stock is only one of many incidental activities, shops have been looked upon frequently as a necessary evil and maintenance expenses have been met when and because they could not be avoided. In addition, the character of railroad accounts has been shaped to meet the requirements of the Interstate Commerce Commission reports. A railroad does not sell the product of its shops in an open market in competition with other shops. Even experienced and successful railroad managers have not learned to appreciate the importance and bearing of many of the factors affecting shop costs. They have not been forced to do so as have industrial managers and have too often closed their eyes to the problem which is recognized to be a complicated one. There were also many easy ways to disguise a number of the factors and allow them to be absorbed in various general accounts.

An unusual combination of conditions recently has led a number of roads to place orders with outside builders for the repairs of locomotives and cars. As orders for new equipment were lacking, builders have been glad to accept such contracts and thus keep their plants in operation. Other roads are considering taking similar action. The question naturally and always asked at such a time is "How will the cost for work done in the contract shop compare with the cost for the same work done in our own shops?" This is a question which is easy to ask but difficult to answer. Certain figures in connection with the cost of work done in railroad shops may be available, but when they are analyzed they are found to be exceedingly incomplete and lacking in many elements. Railroads have not accumulated records which are of much value or aid in making a decision in such a case.

Realizing the importance of a more complete knowledge, one of the large railroads recently called in a corps of trained accountants to obtain the cost of rebuilding 50 box cars in their own well-equipped shops and the cost of similar repairs to an equal number of the same kind of cars in a contract shop. Every effort was made to select cars which were in a similar condition and the local railroad officers co-operated heartily in the effort to secure full information. The results of this investigation are given in an article appearing in this issue. The difficulties experienced in obtaining some of the necessary information, the factors considered and their bearing on the total costs are most enlightening and bring out distinctly many things which are too frequently overlooked, but cannot be ignored if cold facts are desired instead of a mixture of facts, guesses and omissions.

Encourage the Man Down the Line

The lot of the foremen and local supervisory officers in the mechanical department is often difficult and trying. They are confronted every day with petty troubles that are nevertheless serious in their effects. The labor problem, which to the higher officer is a question to be settled on broad general principles, presents itself to the local officer more as a personal problem involving men with whom he is closely associated. Delays and engine failures and the occasional derailments and wrecks are vexatious to the higher officer when he sees them on the morning report, but they are only an incident in the affairs of the day. For the man down the line they mean hours and sometimes days of continuous exertion that taxes his patience and his physical endurance. To the conscientious foreman the position calls for the best efforts he can put forth, and though the responsibility may be limited to a small plant the problems are often just as difficult as those of the man higher up. Anyone who is familiar with the situation can understand why the problem of getting and keeping the right kind of foreman is one of the most serious the roads are facing.

The first step needed to place foremanship on a better basis is a recognition by the management of the true position of the local officer. Too often the foreman is not taken into the confidence of the management. He is not made to feel that he can look to the higher officer for whole-hearted co-operation in solving his problem and often he is not properly supported in doing constructive work. Personal contact with other foremen and with his superiors, while not discouraged, is seldom encouraged. The head of the department is usually busy and finds little time to cultivate a personal acquaintance with the men. Probably he does not intend to keep aloof from the local officers, but if his actions give that impression, the effect is much the same. The foreman's most direct contact with his superior is likely to come when things have gone wrong. He may get an incorrect impression from a letter written in a critical tone after some unavoidable failure. It is hard to keep up courage when the best effort meets with criticism. The natural reaction is to seek to avoid censure and to concentrate attention on minor details; to do the work in a thorough but mediocre way, working to get by, without ambition, without inspiration.

The desire to avoid censure is strong in every normal man, but a feeling that is quite as general and in an ambitious man even stronger is the desire for approbation. If only a man's mistakes are noted, his chief aim will be to avoid such mistakes. On the other hand, if his constructive work is recognized, he will try to do more constructive things. Almost every railroad office has someone on the alert to mete out criticism for each mistake, but how many letters of commendation are ordinarily written to the man down the line? Would it not help matters if the foreman, vexed and discouraged with his many difficulties, could be made to feel occasionally either by an interview or by a cheerful letter that the management realized his position and appreciated whatever constructive work he had done?

A Brighter Outlook for Car Repairs

There are a number of signs which point to the possibility for soon effecting a much needed improvement in freight car conditions. For the month of August reports from some 200 Class I railroads show a net operating income of approximately $90,000,000, the largest for any month since August, 1919. This was an increase from approximately $69,000,000 for the same roads for the previous month, which in turn was the largest net income for any month since October, 1920, the last month of good returns before the heavy decline in traffic set in. It is true that this result has been obtained by drastic curtailments of maintenance expenditures. But if previous experience is any criterion, the prospects are good for a continuing increase in the volume of traffic through September and October before the normal seasonal decline in traffic movement may be expected to set in. Such, in fact, has been the case during September. That this showing has actually justified some increase in the volume of car maintenance is evident from the fact that the first decrease in the number of bad order cars for the year was shown by the report of the Car Service Division for the first half of August.

Since there is a considerable reserve of idle motive power tied up in good order it seems probably that the heaviest increases in maintenance of equipment expenditures may be expected in the car department. With approximately 16 per cent of the freight cars of railroad ownership out of order, three-quarters of which are in need of heavy repairs, such increases in car repair work as take place should be devoted to heavy repairs. On much of the equipment now in bad order this class of repairs has been deferred for years—in many cases probably since before Railroad Administration control. Undoubtedly many of these cars in need of heavy repairs could successfully be returned to service by a continuation of the patch work practice which has so long been in effect. Continually deferring the needed heavy repairs, however, constantly adds to the volume of light repair work without decreasing the heavy repairs which ultimately must be taken care of. The inevitable result is an increase in the average cost of maintenance which the roads can ill afford to continue. Throughout the period during which the number of bad orders has been increasing there has been little increase in the number of light repairs, indicating that this class of work has been taken care of currently even under the present scale of curtailed expenditures. Any increase in expenditures made possible by the steadily improving financial situation should be devoted to a permanent improvement of freight car conditions.

A Fire in the car shops of the Missouri, Kansas & Texas at Wichita Falls, Texas, on September 20, damaged the woodwork mill, several freight cars, a crude oil tank and the entire machine shop equipment—estimated loss, $75,000; cause, unknown.

COMMUNICATIONS

Insulation of Freight and Passenger Cars

New York.

To the Editor:

I have read with much interest the discussion in your issue of September, 1921, by Arthur J. Wood, and I am glad indeed that my article as published in your July, 1921, issue has at least caused comment and criticism.

The subject is beyond doubt one which should receive the attention of all railway engineers, due to the varied interpretations that have been placed on the efficiencies of insulating materials, and while Mr. Wood's criticism is helpful, yet it is not conclusive, as he does not offer in a concrete form some real definite plan which may or may not be accepted by engineers as being finally correct.

I mentioned the fact in the opening paragraphs of my article that there existed great differences of opinion on this subject of insulation, dating back to the time of Jean Claude Peclet, nearly a century ago. We have had quite a number of investigations carried on in the various laboratories since that time, and during the past few years we have also had some very able papers presented before the various engineering societies as well as investigations by the following:

U. S. Bureau of Standards: A. C. Willard and L. C. Litchy; H. C. Dickinson and M. D. Van Dusen, University of Illinois Engineering Experiment Station; Prof. Charles Ladd Norton, Massachusetts Institute of Technology; L. B. McMillan, University of Illinois; Charles H. Herter, paper read before A. S. M. E.; R. L. Shipman, paper before Third International Congress of Refrigeration, 1913; J. A. Moyer, Pennsylvania State College; Arthur J. Wood and E. F. Grundhofer, Pennsylvania State College, and many others that could be mentioned.

The basis of most of our investigations have, however, been built up on the results obtained by the eminent French physicist Peclet and investigations by Rietschel and Grashof.

The principal difficulty seems to lie in the varied types of apparatus used in the experiments and which naturally give different results. In time we will no doubt have to arrive at a satisfactory method acceptable to the engineering field.

The methods most commonly employed in this country may be classified according to principle at least as follows:

1. Ice Box Method.
2. Oil Box Method.
3. Cold Air Box Method.
4. Hot Air Box Method.
5. Flat or Hot Plate Method.

The following is an excerpt from Bulletin No. 102 issued by the University of Illinois:

"The most prominent American investigator has been Prof. C. L. Norton of the Massachusetts Institute of Technology. The best equipped thermal-transmission testing plant in this country has been erected by the Armstrong Cork Company, at Beaver Falls, Pa. A similar plant is located at the Pennsylvania State College at State College, Pa. In the tests run at the former plant little attention has been given to surface temperatures, since only actual or overall transmission air to air coefficients were desired. In the plant at Pennsylvania State College both air and surface temperatures are measured by means of platinum resistance pyrometers, and the Engineering Experiment Station at State College has been studying the effect produced on the heat transmission by varying the relative humidity and velocity of the air passing over the outside surface of a building wall.

"The Worcester Polytechnic Institute has recently conducted a series of tests on the heat transmission of various types of ice house construction. Prof. J. R. Allen, University of Michigan, has recently reported the results of tests on transmission coefficients for glass made under a variety of conditions."

There has been very little data published on the subject of "car insulation" and the writer is perfectly satisfied that after the subject is further investigated there will be some recommendations that would be of considerable value.

In my discussion on this subject I have taken what I consider the nucleus of all the latest experiments and brought together the salient points regarding methods for arriving at transmission factors.

The matter of air space in the walls of passenger and freight cars probably cannot be counted on for much value, and in many cases might just as well be omitted, as there are practically no instances where such an air space will remain a dead air space for an indefinite period of time. Therefore, the question of air space is debatable. However, the writer has given the benefit of a certain value in his article and which is according to good practice at the present time. Undoubtedly the best and most dependable results will be obtained by dividing up air spaces and inserting layers of insulation which more nearly approaches the so-called "dead air space."

Mr. Wood is correct in his reference to Table III to the effect that the values of C and K are transposed as this table was reproduced from tests made by the U. S. Bureau of Standards and the error has been handed down, but in the discussion the value of one was used for average conditions.

So far as surface resistance is concerned, and in view of the uncertainty of same, the value as used; namely, $\frac{1}{K}$ or 0.5 was used as the total for inside and outside surfaces combined, this representing good practice based on recent tests.

The writer quite agrees with Mr. Wood that there is a need of more extended scientific investigations to assist in a better design of insulated walls, and this would be an excellent subject for the American Railway Association to take up and establish a definite method for testing the value of insulations such as are used in car construction. This would then establish a standard basis to be used, and eliminate or reduce to a minimum the varied methods now employed.

The Pennsylvania State College has contributed some exceptionally good information on this subject of heat transmission and with the excellent laboratory equipment we should no doubt learn much through their very able studies. Arthur J. Wood and E. F. Grundhofer have recently presented a very valuable paper on this subject.

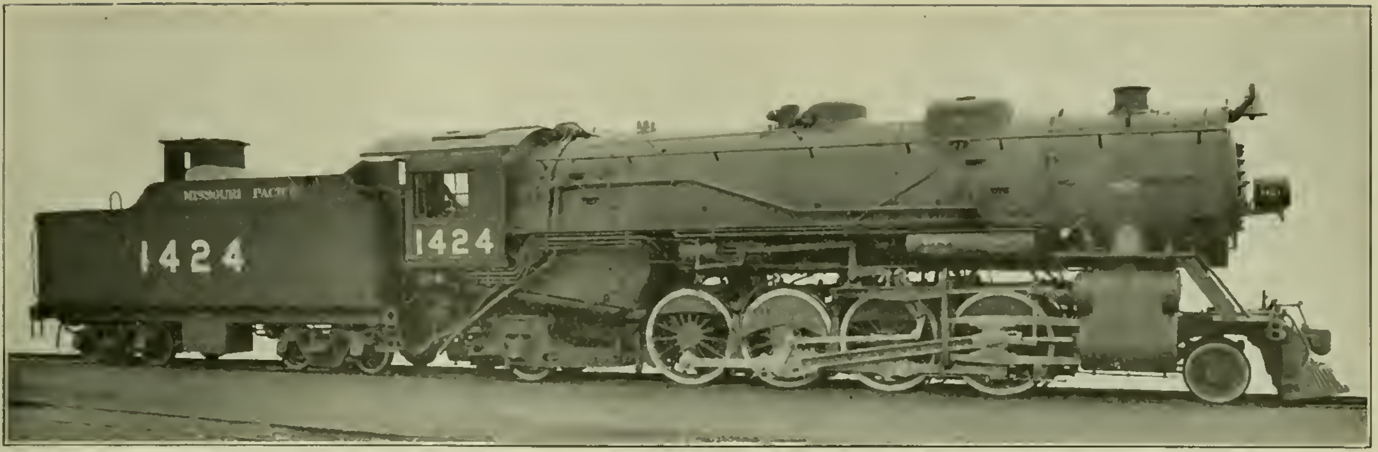
The writer is not prepared to offer any particular criticism as regards the values obtained by the Standard Car Committee in the Union Pacific tests, but merely reproduced the figures purely for a comparative basis.

The conductivity value of 6.576 used for the insulation in the formulas is correct for the hair insulation as this figure is borne out by later tests, and by referring to Table II it will be found that for Keystone Hair Felt the conductivity value given is 6.5, which checks very closely with the value of Salamander insulation, used as the basis for calculation.

The object of my discussion was to bring to the attention of railway engineers a suggested method of procedure for their guidance in arriving at the heat transmission of car walls without laying too much stress on values of conductivity, as these values would have to be selected from some accepted authority.

The subject is a deep one and quite complicated and I know of none in the engineering field upon which there is such a variance in opinions, but eventually we will no doubt arrive at a satisfactory solution.

Wm. N. Allman.



Mikado Type Locomotive Equipped with Booster

New Locomotives for the Missouri Pacific

Harter Circulating Plates Applied to Improve Boiler Capacity—Booster Increases Tonnage 13 Per Cent

THE Missouri Pacific has recently added to their equipment 50 locomotives built by the American Locomotive Company. This includes 15 six-wheel switchers (0-6-0 type), 25 Mikado (2-8-2 type), 5 Pacific (4-6-2 type) and 5 Mountain (4-8-2 type) locomotives, none of which types are new on this road. The six-wheel switchers are of the same design as those received about a year ago; the Pacific type engines are practically a duplicate of those previously built, while the Mikado and Mountain types are of entirely new designs.

Mikado Type

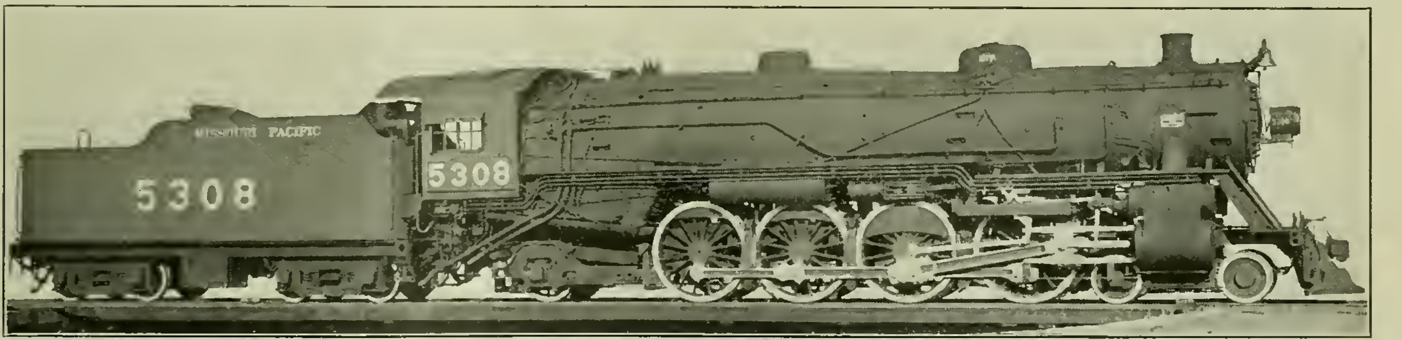
The Mikado locomotives previously used were of the government light, or U.S.R.A. 2-8-2-A type allocated to the road during the war. These engines are of 54,600 lb. tractive effort, have 26 in. by 30 in. cylinders, the total weight being 290,800 lb., with 221,500 lb. on drivers and 63 in. wheels. The new locomotives have 10 per cent greater tractive effort and an equivalent increase in weight and are handling 10 per cent greater tonnage. Among the special features are floating bushings for the middle connection bearings which are giving much better satisfaction on engines of this size than the stationary bushings previously used; Alco reverse gear; Duplex type D stokers; Franklin grate shakers and adjustable driving box wedges; Chicago flange lubricators and Jemco unit spark arresters which are said to be an improvement over the master mechanics' design in ease of application, convenience in maintenance and reduction of fire hazards.

The boilers of the Mikado type as well as the other locomotives are equipped with Harter circulating plates which it is estimated have added 10 per cent to their capacity. This device consists essentially of a horizontal plate slightly below the center line extending entirely across the boiler from a point just behind the feedwater inlet to within about six inches of the back tube sheet. Outlets for steam are provided by pipes placed at intervals on either side which lead to the steam space at the top of the boiler barrel. The general arrangement is shown in the drawing of the boiler for the Mountain type locomotives.

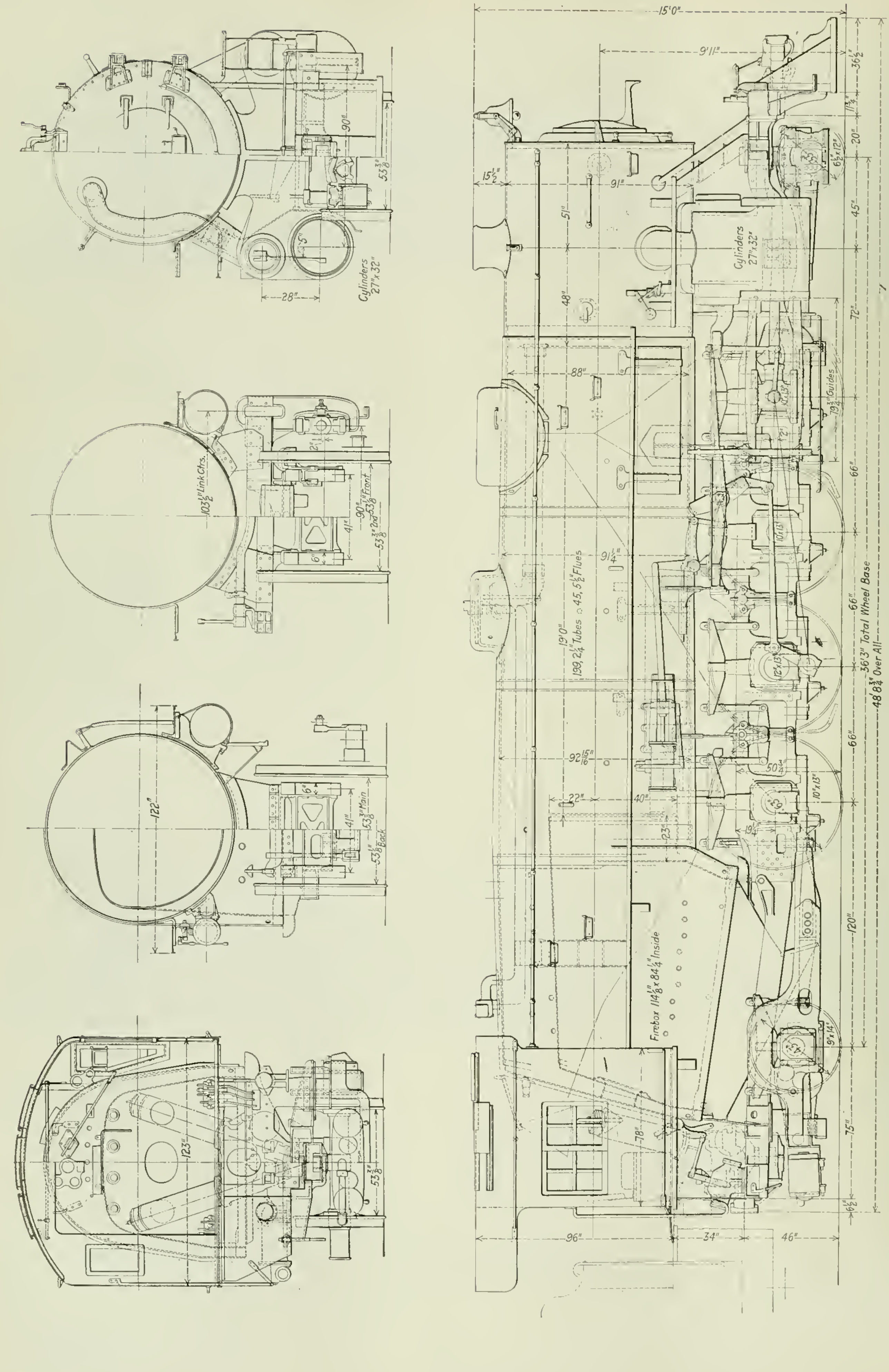
On the Mikado locomotives the boiler horsepower is 93.9 per cent of the cylinder horsepower without allowance for the circulating plate and on the Mountain type, the rated boiler power is even less. All of the engines have, however, proved to be free steamers in service.

Delta trailing trucks, equalized with the drivers and equipped with brakes, are used on all road engines. Of the 25 Mikado engines, two are equipped with boosters and provision is made for their future application to the other engines. In actual service it has been found that the locomotives equipped with boosters can handle 13½ per cent more tonnage than the same design of engines without the booster.

The booster increases the tractive effort 9,000 lb. and

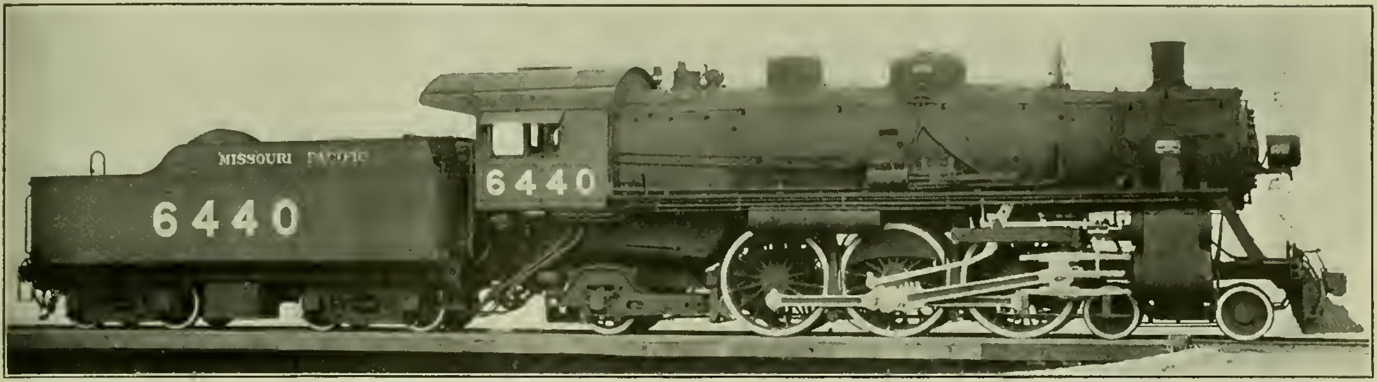


An Efficient Mountain Type Locomotive of Medium Weight



Elevation and Sections of New Mikado Type Locomotives for the Missouri Pacific adds 3,500 lb. more weight on the trailing truck, 4,500 lb. more on the drivers and 1,000 lb. less on the front truck.

The ruling grade on the line where the boosters are used is five miles long so that the demand on the boiler for steam to supply the booster as well as the locomotive cylinders is severe and prolonged and any lack of capacity would be developed quickly. In actual tests the locomotives have handled a full tonnage over the ruling grade at a speed of approximately 10 m.p.h. With the reverse lever in the corner, the throttle wide open and the injector on, full boiler pressure was maintained.



Pacific Type Locomotive of 40,000 lb. Tractive Effort

Mountain Type

The Missouri Pacific has been using for some time a number of U.S.R.A. 4-8-2-A light Mountain type locomotives which have a tractive effort of 53,900 lb., 27 in. by 30 in. cylinders, total weight 327,000 lb., 224,500 lb. on drivers and 69 in. wheels. The new locomotives were designed for the same service and to correct some of the troubles which have been experienced with the older ones. In attempting to make pronounced changes in the design, an interesting problem was encountered owing to the fact that the condition of bridges and structures on the section of the road where the engines were to be used necessitated limiting the weight on the drivers to 226,000 lb.

The size of the driving wheels was increased to 73 in. to fit them better for the speeds at which the passenger trains are scheduled and lateral motion driving boxes were applied on the front pair of drivers to lessen the rigid wheel base and eliminate the trouble with hot bearings. These modifications naturally necessitated a longer boiler which would tend to increase the weight beyond that allowable. The previous engines had a rated boiler horsepower capacity of 97.5 per cent of the cylinder horsepower. In order to keep the weight

Comparison and Ratios of the Missouri Pacific's New Locomotives

	0-6-0 Switcher	2-8-2 Mikado†	4-6-2 Pacific	4-8-2 Mountain
Tractive effort (85 per cent)	39,100 lb.	59,800 lb.	39,500 lb.	53,500 lb.
Cylinders, diameter and stroke	21 in. by 28 in.	27 in. by 32 in.	26 in. By 26 in.	27 in. by 30 in.
Valves, size and kind	10 in. piston	14 in. piston	14 in. piston	14 in. piston
Greatest travel	6 in.	7 in.	6½ in.	7 in.
Lap	1 in.	1 3/16 in.	1⅛ in.	1¼ in.
Exhaust clearance	1/16 in.	0	3/16 in.	3/16 in.
Lead in full gear	0	⅛ in.	3/16 in.	3/16 in.
Weight in working order:				
On drivers	163,000 lb.	233,000 lb.	166,500 lb.	226,000 lb.
On front truck	....	30,500 lb.	49,000 lb.	52,500 lb.
On trailing truck	....	56,500 lb.	52,000 lb.	56,500 lb.
Total engine	163,000 lb.	320,000 lb.	267,500 lb.	335,000 lb.
Total engine and tender	287,800 lb.	510,000 lb.	435,700 lb.	527,800 lb.
Wheel base, driving	11 ft. 6 in.	16 ft. 6 in.	13 ft. 0 in.	19 ft. 7 in.
Rigid	11 ft. 6 in.	16 ft. 6 in.	13 ft. 0 in.	12 ft. 8 in.
Total engine	11 ft. 6 in.	36 ft. 3 in.	33 ft. 7 in.	41 ft. 4 in.
Total engine and tender	43 ft. 10½ in.	71 ft. 1½ in.	67 ft. ¾ in.	77 ft. 2 in.
Wheels and journals:				
Driving, diameter over tires	51 in.	63 in.	73 in.	73 in.
Driving journals, main	9½ in. by 12 in.	12 in. by 13 in.	10½ in. by 12 in.	12 in. by 13 in.
Driving journals, front	9 in. by 12 in.	10 in. by 13 in.	10 in. by 12 in.	10 in. by 19 in.
Driving journals, others	9 in. by 12 in.	10 in. by 13 in.	10 in. by 12 in.	10 in. by 13 in.
Boiler, style:	Ext. Wagon Top	St. Top	Ext. Wagon Top	Conical Conn.
Diameter, inside first ring	64 11/16 in.	88 in.	72⅜ in.	76⅝ in.
Steam pressure	190 lb.	190 lb.	193 lb.	210 lb.
Firebox, length and width	78 in. by 70¼ in.	114⅛ in. by 84¼ in.	108 in. by 66 in.	114⅛ in. by 84¼ in.
Grate area	38 sq. ft.	67 sq. ft.	49.5 sq. ft.	67 sq. ft.
Tubes, number and diameter	158—2 in.	199—2¼ in.	207—2 in.	182—2¼ in.
Flues, number and diameter	24—5½ in.	45—5½ in.	32—5⅜ in.	40—5½ in.
Tubes and flues, length	14 ft.	19 ft.	20 ft.	22 ft.
Heating surface, firebox	145 sq. ft.	263 sq. ft.	207 sq. ft.	300 sq. ft.
Heating surface, arch tubes	....	27 sq. ft.	26 sq. ft.	27 sq. ft.
Heating surface, tubes	1,149 sq. ft.	2,214 sq. ft.	2,155 sq. ft.	2,346 sq. ft.
Heating surface, flues	480 sq. ft.	1,223 sq. ft.	895 sq. ft.	1,261 sq. ft.
Heating surface, total evaporative	1,774 sq. ft.	3,727 sq. ft.	3,283 sq. ft.	3,934 sq. ft.
Superheating surface	393 sq. ft.	1,051 sq. ft.	778 sq. ft.	1,084 sq. ft.
Equivalent heating surface*	2,363 sq. ft.	5,303 sq. ft.	4,450 sq. ft.	5,560 sq. ft.
Tender:				
Water capacity	6,000 gal.	10,000 gal.	8,000 gal.	10,000 gal.
Fuel capacity	10 tons	16 tons	14 tons	16 tons
Ratios:				
Weight on drivers ÷ tractive effort	4.3	3.9	4.2	4.2
Total weight ÷ tractive effort	4.3	5.3	6.8	6.3
Tractive effort ÷ equivalent heating surface	16.5	11.3	11.3	9.6
Tractive effort × diameter drivers ÷ equivalent heating surface	844	711	823	702
Equivalent heating surface ÷ grate area	62.3	79.2	89.9	83.0
Weight on drivers ÷ equivalent heating surface	68.9	43.9	37.4	40.6
Total weight ÷ equivalent heating surface	68.9	60.4	60.1	60.3
Firebox heating surface ÷ equivalent heating surface, per cent	6.1	5.0	4.6	5.4
Volume of cylinders, cu. ft.	11.2	21.18	15.96	19.86
Equivalent heating surface ÷ volume cylinders	211	250	278	280
Grate area ÷ volume cylinders	3.4	3.2	3.1	3.4
Superheater surface ÷ evaporative surface, per cent	22.1	28.2	23.7	27.5

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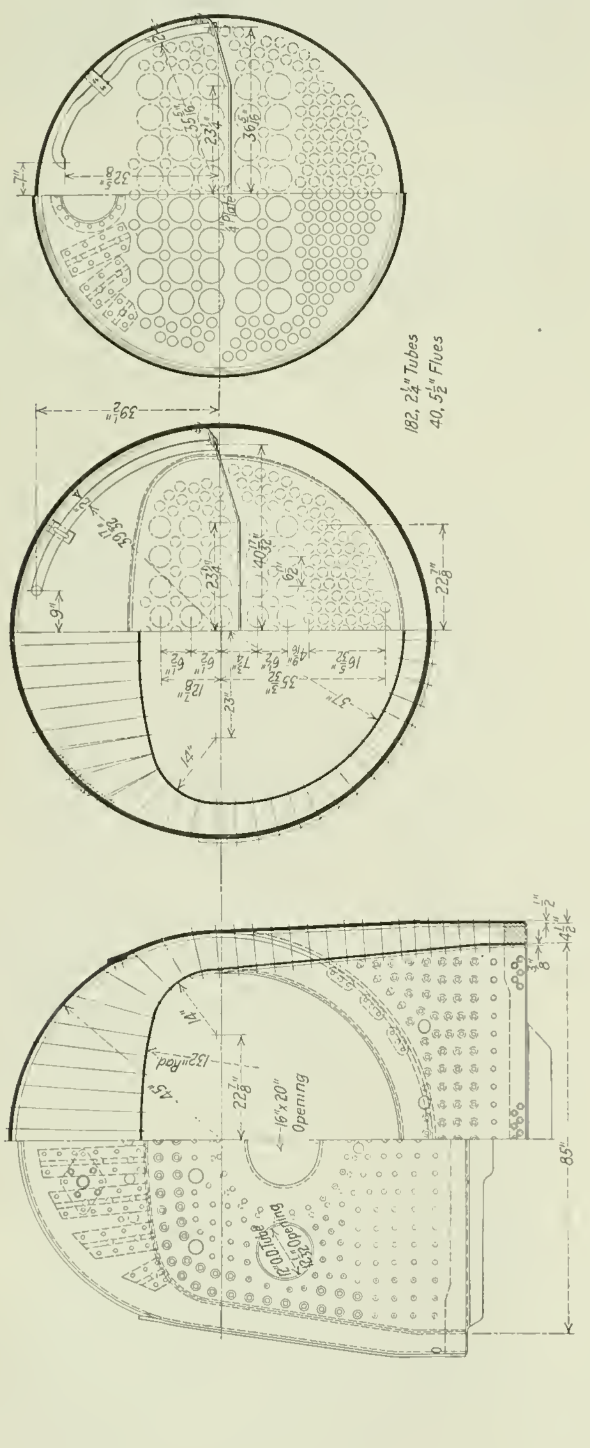
*Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.

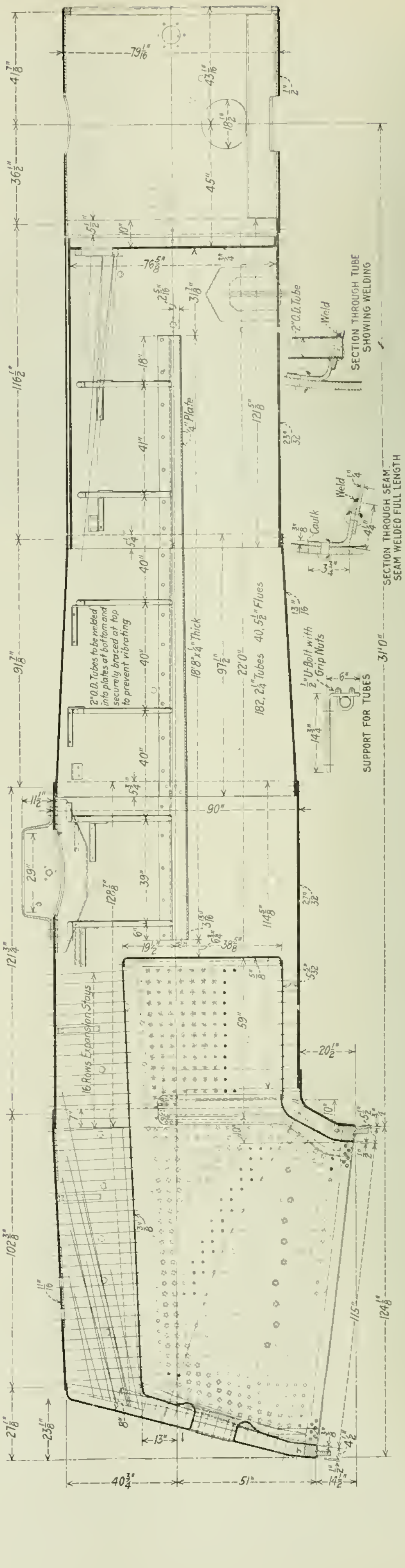
†The weights and ratios for those without booster.

within the maximum allowable, it was decided to reduce the boiler size so that its rated horsepower was only 85.3 per cent of the cylinder horsepower. This it was thought could be done safely by using Harter circulating plates to increase the boiler capacity. In the new design the boiler pressure was increased from 200 lb. to 210 lb., the firebox was made 6 in. shorter, the length of tubes was increased from 20 ft. 6 in. to 22 ft. and the number decreased from 216 to 182.

The new Mountain type locomotives are being run in a pool with the older locomotives and consequently both are handling the same trains on the same division. Both designs have the same size cylinders. Despite the smaller boiler, the new engines steam just as freely as the older ones, are running with ¾ in. larger exhaust nozzles, are making better fuel records and take the same train 30 miles further for water.

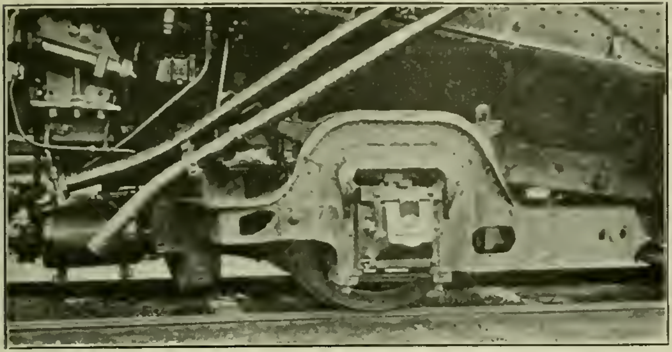
The locomotives are provided with floating bushings in the middle connections and the same attachments furnished





Sections of Boiler with Harter Circulating Plate for Mountain Type Locomotive on the Mikado type. Boosters were not applied but provision was made for their attachment in the future.

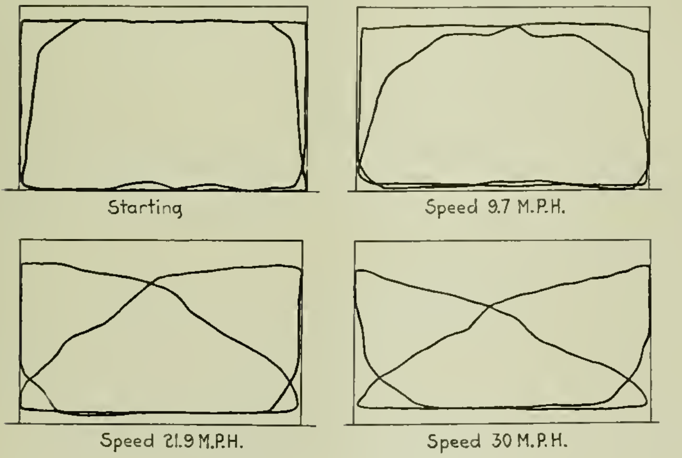
As has been stated, the Pacific and switch engines are practically the same as previous engines but are provided with Harter circulating plates. The Pacific type locomotives are operating with exhaust nozzles from ½ in. to ¾ in. larger than was previously possible and are showing an improved fuel record and better performance in general than the older design of locomotives.


Booster and Delta Truck Used on Mikado Locomotives

A table showing the principal dimensions and ratios of the four types of locomotives is given for comparison with other designs.

Long Stroke Cylinder Tests on Southern Pacific

In the description of the new locomotives of the 4-6-2 and 2-10-2 types for the Southern Pacific given in the *Railway Mechanical Engineer*, August 1921, attention was called to the use of long piston stroke which was adopted as the result of a series of experiments. The new locomotives of the 4-6-2 type have 25 in. by 30 in. cylinders with 73½ in. driving wheels whereas the older engines have 22 in. by 28 in. cylinders with 77½ in. wheels. The new locomotives of the 2-10-2 type had 29½ in. by 32 in. cylinders and the older engines 27½ in. by 32 in. cylinders, both designs having 63½ in. wheels. These changes give the new Pacific type locomotives 13.2 per cent higher piston speed for the same running speed and whereas the older locomotives have a piston speed of 1,000 ft. per min. when running at 49.5 m. p. h. the new locomotives have the same piston speed when running at 43.8 m. p. h. For heavy mountain passenger service on long grades up to 1.5 per cent, the higher relative piston speeds are giving better results, as would be expected from the fact that the maximum horsepower of superheated locomotives is obtained at a piston speed of approximately 1,000 ft. per min. or higher.


Starting

Speed 9.7 M.P.H.

Speed 21.9 M.P.H.

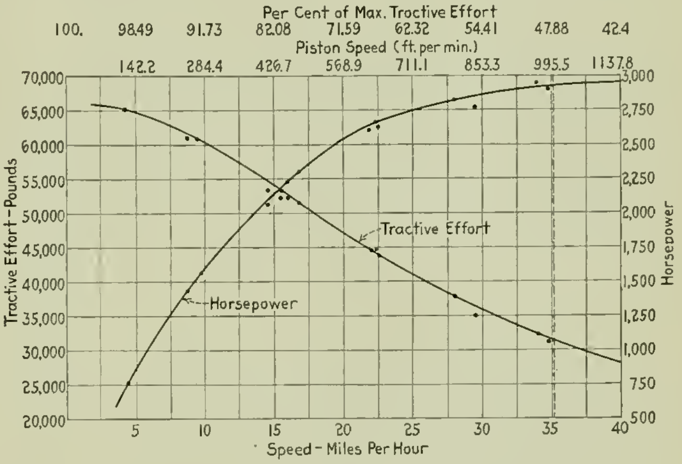
Speed 30 M.P.H.

Typical Indicator Cards

To determine the effect of the long stroke on the mean effective pressure developed, a number of the tests were made with 2-10-2 type locomotives, Southern Pacific Class F-1, built in 1917 and 1919. These engines have a rated tractive effort of 65,300 lb. at 85 per cent of the boiler pressure, weigh 348,000 lb., of which 273,000 lb. is on the drivers, and have 63½ in. wheels (new), or about 63 in. at the time of the tests. Other leading dimensions were given in the tabulation on page 482 of the *Railway Mechanical Engineer*, August 1921.

In connection with the tests it may be of interest to add that the valves were of the piston type, 15 in. diameter, greatest travel 7¼ in., lap 1¼ in., exhaust clearance ⅛ in., and lead in full gear ¼ in.

Indicator cards were taken of both cylinders at various speeds up to 35 m. p. h. Four typical cards are shown herewith which were taken when starting and at speeds of approximately 10, 20 and 30 m. p. h. The following table gives the results calculated from these and a number of other cards.



Horsepower and Tractive Effort Curves

Speed, m. p. h.	Steam pressure, lb.	Mean effective pressure, lb.	Tractive effort, lb.	Reverse lever notch
Starting	198	173.4	65,790	Corner
4.35	200	171.9	65,230	Corner
9.7	198	159.7	60,600	5
15.5	200	137.8	52,290	9
21.9	200	117.4	44.550	11
24.5	200	105.3	39,940	10
30.0	199	88.8	33,700	12
34.8	200	82.5	31,300	12

Curves showing the horsepower and the tractive effort at various speeds were plotted from the indicator cards and the dynamometer car records. As these curves are particularly interesting, one of them is shown. The recorded starting tractive effort of 66,000 lbs. corresponds well with the nominal rated tractive effort of 65,300 lbs. based on 85 per cent of the boiler pressure. The maximum horsepower developed was 2,950. This corresponds to one horsepower for every 118 lbs. of the locomotive weight, a very satisfactory proportion.

In view of the high mean effective pressures shown by the indicator cards and the excellent horsepower and tractive effort results, the use of long stroke cylinders appeared to be well warranted. Results obtained from the new engines which have now been in service for some time are reported to fulfill all expectations.

Informal Meeting of Traveling Engineers

Hiring of Firemen, Conservation of Supplies and Operation of Locomotive Devices Discussed

THE Traveling Engineers' Association held an informal meeting on September 7 and 8, 1921, at the Hotel Sherman, Chicago. At this meeting, which took the place of the regular annual convention of the association, postponed on account of prevailing business conditions, the reports of a number of the committees which were to have been presented before the regular convention were read and discussed and officers were elected for the ensuing year.

In calling the meeting to order the president, W. E. Preston, Southern Railway, spoke in part as follows:

President Preston's Address

Have you watched the sea in a great storm and noted the waves, mountain high, as they dash against the shore? And have you noted that for hours after the storm has passed and the sky is clear and the wind has ceased to blow, the waves still roll quite as high? The storm has passed, but the effects of the storm still remain.

For four years 40,000,000 men quit peaceful occupations and undertook to destroy each other, together with all the property they could reach. For those who did not go to war was assigned the great task of feeding and clothing those who fought and supplying the implements of warfare. No one has yet even guessed the cost of the conflict. We know that millions of lives were lost, and that the accumulated savings of centuries of industry were wiped away. The conflict is past, but we are left with waves of unrest, with our social and industrial life impaired, with the wreckage of a great storm to clear away.

Civilization is expensive. It costs effort and economy to create the wealth that will support modern life. The world problem is to replace that which was destroyed, that the comfort and security of civilization may be passed on to future generations. There is but one way to meet this cost. That which was destroyed was the product of labor of hands and brains, and was saved through centuries of economy. It is our task to work and save, simple virtues, but real wealth is only created when men work and save.

The contribution of the members of the Traveling Engineers' Association is to supply at minimum cost an article which the modern world stands in great need of—transportation. The world is far short of its demands. Ocean transportation was nearly swept from the seas by the great war. Transportation by highways is growing by leaps and bounds, but will never replace the service that was rendered by the railroads. During the past ten years our population has increased more than 15 per cent, but from the day the world was plunged into war the railroads have been unable to increase terminals, to better their road beds or to improve rolling stock. Members of our organization occupy key positions in supplying this sorely needed commodity—transportation. We are always on the firing line, in the front line trenches. But back of us is a great army of loyal engineers and firemen, trained for their jobs, strong, ready, capable.

The great world need is that men in all walks of life shall work harder and save more of what they produce. The world needs that every locomotive shall work to its full capacity the maximum number of hours each year, at the minimum cost of operation. Not alone for this year, but for years to come, must we contribute our big share to replace what has been destroyed.

Now is the time to stick close to the rigid rules of common honesty, to remember the ten commandments and keep them. The honest man will not accept a day's pay until he has done a day's work. There must be the same honesty in dealing with the corporation as with the individual. The world needs the spirit of Christianity permeating the lives and actions of men. The measure of a man must be not how how much wealth has he taken into his own safety vaults, but how much has he done in his generation to quiet the unrest, to put right the wrong, to house and feed and give comfort to a world whose civilization has been strained near the breaking point.

The world looks to us in America to safeguard the sacred right of man to own property, secure against all interference except by due process of law. It is the law that makes us free. Can you picture a railroad whose trains ran at random, at the mere whim of the engineer, who might claim that because this is a free country he had the liberty to run his train how, when and where he pleased? It is because he and all engineers obey the law that he becomes a free man. He has the freedom of the road when all obey the law.

New Officers Elected

The report of the secretary showed a membership of 1,546, representing a gain of 87 members during the year. The following officers were elected: President, J. H. DeSalis, New York Central; first vice-president, Frederick Kerby, B. & O.; second vice-president, T. F. Howley, Erie; third vice-president, W. J. Fee, Grand Trunk; fourth vice-president, J. N. Clark, Southern Pacific; fifth vice-president, J. B. Hurley, Wabash; secretary, W. O. Thompson, New York Central, and treasurer, David Meadows, Michigan Central. No change was made in the membership of the executive committee except the addition of W. E. Preston, Southern, the retiring president.

Abstracts of two of the reports and discussions follow. Others will appear in later issues.

Conservation of Supplies and in Operation of Locomotive Appurtenances

The subject of the conservation of supplies is logically divided into two parts; First, the conservation at the terminal, and second, conservation on the road.

A suitable building located at the point where all engines arrive and depart, materially affects the conservation of supplies at the terminal. This is where all equipment is kept to supply engines for service. The equipment is checked to the engine crews prior to their departure, and checked in again upon their arrival. This facilitates the keeping of a complete record at all times and enables the party in charge of equipment to account for it if any should be lost or destroyed. If the engine crews know they will be held responsible for the use of supplies upon their arrival at terminals, it will act as an incentive for them to take better care of the equipment.

Where the engines are in pool service, the engineer going out should have an opportunity of seeing the work reported by the incoming engineer. This will give the outgoing man the information that is essential for the proper care of any work that has been done. He will also have a knowledge of defects that have been reported, which the shop forces were unable to attend to and he will thus be able to protect himself and the company from injury.

The adequate supply of lubricant for the trip should be considered highly essential to the conservation of machinery and appurtenances on the engine. Worn cylinders and valve bushings can often be charged to improper lubrication. However, this is seldom due to the fact that an insufficient amount of oil has been furnished. It is more often caused by defects that have not been reported or defects that have been reported and repairs not made. Also, instructions are not always carefully followed as to the right method of lubricating the machine, or perhaps the man in charge is indifferent.

In order to conserve supplies on the road it is imperative that engines be equipped with proper receptacles so that the different articles, such as oil, waste, lanterns, flags, water glasses, fusees and torpedoes, will not be wasted and damaged if not used. If all concerned were advised as to the cost of supplies or the enormous amount of money involved, it would be an incentive to all concerned for their judicious use and care. The co-operation of the employees is paramount. Carry no equipment on the engine that is not required. All surplus equipment should be promptly reported and removed at the home terminal.

Overloaded tenders are dangerous and extravagant, and overflowing tanks at water plugs are wasteful and expensive, for in freezing weather the water often overflows the tracks, which is very dangerous indeed, as well as expensive to clear away.

Enginemen should make intelligent reports as to locomotive conditions; that is, reports by means of which the enginehouse organization is capable of locating the precise defects. Reporting defects in a general way should not be tolerated, and enginemen should be encouraged to make proper reports by having the work done promptly or if the work cannot be done on this trip the engineman should be so advised and the work followed up and done for the next trip. This will encourage enginemen not to grow lax in making detailed reports.

Power Reverse Gears

We wish to note particularly the air losses of the power reverse gear. In many instances adequate forces have not been furnished to maintain this appliance and there are heavy air losses as a result of improper care. With the necessary care this device would result in a saving of fuel and water, as the engineer can adjust the cut-off with so much less exertion. However, with heavy air losses around the rotary and by the cylinder packing, it is next to impossible to regulate the cut-off at short valve travel, which results in the engine being worked at a longer cut-off, with a corresponding excess of consumption of fuel.

Once the steam has been used instead of the air for operating the gear it is of no more use until the piston is repacked.

Piston packing rings improperly cut, and failing to lap properly cause creeping. Also, if they are too tight and hardened, the rubber having lost its resiliency they will not keep tight contact with the cylinder wall.

Hardened packing in the piston gland, scored rod or worn parts—any blow here will cause creeping.

Leaky drain cocks or cylinder oil cups will cause creeping.

On some gears there are cone-shaped valves for the distribution of air to the power reverse and these valves cause considerable trouble because of leaks, which will cause creeping when the reverse lever is hooked up. Leaky rotary valve will also cause this trouble; however, this seldom gives any trouble. Cases have been found where the stop pin is broken off and wedged between the rotary faces, damaging them; but under ordinary wear the rotary stands up well.

When the reverse gear valve assembly is changed, it is absolutely necessary to check the length of the long connection rod to the cylinder lapping lever. In some cases it had to be changed in length as much as 1½ in. Failing to do this the links will touch bottom at one end and have too short maximum cut-off in the other end.

Lost motion in pins and connecting rods of the reverse should not be tolerated.

Owing to the fact that the gear receives most of its wear in hooked-up position, in time the cylinder increases in diameter at that part of the stroke and the piston rod decreases in diameter at the corresponding place. A gear that is worn this way will be a constant source of trouble from creeping and jumping.

Rotary, cylinder and connecting rod pins should be well oiled. Make sure that the steam shut-off valve is not leaking condensation into the reverse.

Cases have been found where the long connecting rod had several bends in it. This rod should be of sufficient size to avoid bending.

Locomotive Headlight Equipment

Any engineer operating locomotives equipped with electric headlights should make this a part of his study, in connection with his other duties. He should see before leaving the terminal that the dynamo has been well oiled and cared for and that his headlight is equipped with incandescent globes, also that he has sufficient lights placed in proper position in the cab, in order to furnish light to all the equipment he has to handle. He should bear in mind that the dynamo is the most vital part of the equipment and that he should pay particular attention to the condition of this machine at all times, keeping constantly in mind that all the bearings should be kept oiled. The governor will get out of order once in a while and will not control the speed of the machine as it should. When this condition develops, if the engineer does not take notice, it will result in the cab lights being burned out, especially if the headlight is cut out from the switch in the cab. In order to handle this situation, the engineer should throttle the machine down by the throttle in the cab. The engineer should bear in mind that if his hours are long in making the run over the division, at night, the machine should be lubricated between terminals. He should also see that his headlight is properly focused. There is no one who has a better opportunity of keeping the headlight properly focused than the engineer. After completing the trip, if there are any conditions about this equipment causing it not to function properly, he should make an intelligent report and have conditions properly cared for at the terminal before the engine is allowed to go out again.

The Superheater

Enginemen should be taught the disastrous effects of carrying high water with this device. It not only converts the appliance into a steam dryer, but is very apt to cause the unit joints to leak and also to form a coat of lime or sediment on the inside of the tube, which substantially affects the degree of superheat obtained. It has been discovered that in extreme cases of carrying water too high in the boiler the superheat units have become completely clogged. Moreover, superheater headers have been broken, due to an excessive amount of water or filling the boiler too full while the engine was laying up at terminals.

Enginemen should receive instructions to closely observe the operation of the damper, for if the damper does not close when the throttle is closed, the superheater units will become overheated and will not only cause the unit joints to leak, but will have a tendency to crack the return bends and thus cause a complete engine failure.

The committee deems it best to place an independent lubricator on the locomotive for the purpose of lubricating the stoker engine or motor, placing it convenient to the fireman. We do not wish to relieve the engineer of the responsibility of caring for this machine when on the line of road, but the fireman should be held responsible by the engineer for the proper care of this machine. It will in a measure fit him for greater responsibilities in the future. The fireman should see that all parts are lubricated while on the line of road, and where the coal is not prepared he should watch closely for any foreign matter which would be liable to cause a stoker failure. The engine crew should see that the conveyer hopper is empty on arrival at the terminal and all slides closed. This will prevent the conveyor being overloaded or clogged when the engine is coaled.

The report is signed by J. P. Russell (chairman), Southern; J. A. Mitchell, N. Y., N. H. & H.; W. J. Fee, Grand Trunk; H. E. Reynolds, C. R. I. & P., and E. Von Bergen, Illinois Central.

Discussion

The discussion of this report was confined almost entirely to the methods of handling locomotive supplies and tool equipment. E. Von Bergen (Illinois Central) described a monthly report which is being made up to show the amount of supplies issued to various engine crews, from which any cases of excessive issues may readily be determined and investigation made to learn the cause and apply corrective measures. The discussion disclosed a lack of uniformity in the methods of checking supplies on and off locomotives. In some cases they are checked both at the outgoing and the incoming terminal. In other cases they are checked out and in at the home terminal only. The use of individual tool boxes of convenient size which can be handled by the enginemen has met with considerable success in conserving the small tools required on locomotives, the engine crews showing considerable interest in taking care of this equipment. In any case the greatest trouble is experienced in looking after the tools while the engines are in the terminal. This is particularly true where the tools are assigned to the locomotive and are taken off after the crew leaves the engine by the supply room attendant.

One advantage which has developed from providing private tool boxes for the enginemen is the incentive which this provides each engineman to accumulate a few tools of his own with which he will make repairs on the road that otherwise would not be made.

The greatest difficulty is experienced in conserving the issues of torpedoes and fusees, one reason being that it is difficult to determine closely the number of occasions arising which actually require their use as intended.

Self-Adjusting Wedge, Feed Water Heater and Booster

The present standard wedge is of the manually adjusted style. It is designed to take up the wear between the driving boxes and the shoes and wedges brought about by the up and down movement between the frame and the boxes. This wear, if not taken up, results in undue freedom of the box between the shoe and wedge. This lost motion is the cause of the so-called "box pound" due to the movement of the box backward and forward between the shoe and the wedge. This brings about a side wear of the crown brasses and a tendency to break these bearings. The hammer-like blows struck against the shoe and wedge by this backward and forward movement of a loose box may result in broken shoes and wedges, and these blows become a prolific cause of broken frames. This lost motion of the boxes, which usually affects the different wheels unequally, tends to cause a variation from the distance intended in the locomotive design in the distance between the centers of the rod bearings. The main driving boxes, due to the greater thrust brought to bear upon them, as a rule, develop the most wear. This wear of the main driving boxes throws undue strain on the side rod bearings, tending to cause rod pounds, broken side rod bushings and brasses, and possibly bent and broken side rods.

Lost motion in connection with main wheel driving boxes tends to increase the steam piston stroke and shorten the steam cylinder clearance space at the end of stroke, and when allowed to become extreme may bring about cylinder knocks due to the steam piston striking the cylinder heads with a tendency to knock them out. Lost motion of the main driving boxes is taken up by the steam piston at the beginning of its stroke and live steam is thereby permitted at any given valve cut-off to follow the piston further than intended, thus causing a loss in expansion value of the steam, and a loss of fuel.

The taking up of lost motion existing in main driving box parts through steam piston pressure moves the main driving wheels bodily back and forward to the extent of such lost motion, thus setting up a tendency for the wheels to slip during this movement. This is claimed to be a most common cause of wheel slipping and of troubles in that connection in moving heavy trains, especially where the rails are bad or conditions adverse.

That these results of failure to prevent undue lost motion of the driving boxes in the frame are frequently the cause of locomotive failures and always a source of increased maintenance cost is too well known to require further comment.

The engineman has always been held responsible for allowing any such undue lost motion, and until within the past few years usually attended personally to the setting up of the adjusting wedges. The most that is expected of him today is that he shall report any looseness or pounding of the driving box parts, the actual work of setting up the wedges, devolving on the roundhouse forces. This condition has not brought about a change for the better.

When the engineman himself took care of this work, it was his practice to so spot the locomotive that the driving boxes were forced up against the shoes, thus giving all possible free play between the driving boxes and the wedges and permitting the wedges to be forced up to the extent necessary to eliminate all lost motion; the wedge was then slightly pulled down to provide the required freedom of movement of the box and to prevent its sticking. It is now not uncommon practice in roundhouses for employees assigned to do this work upon report of the engineman to undertake to adjust the wedges without moving the locomotive at all, thus frequently not fully accomplishing the object desired and thereby permitting the locomotive to return to service in a condition detrimental to itself and the railroad.

The value of a self-adjusting wedge, simple in its design and non-erratic in its action, will readily appeal to all who have to do with either the handling of the locomotive or its maintenance. To the engineman it would mean a more efficient and satisfying machine, to the mechanical department an incalculable benefit in the savings effected in maintenance cost through the tendency to prevent the many troubles herein mentioned as arising through failure to properly keep up the wedges and through the reduction of locomotive failures due to these causes as well as a very considerable saving in the cost of roundhouse labor now required to do the adjusting of wedges, and doing it none too efficiently. In which direction the savings would lay, would, of course, depend largely upon the previously existing conditions.

At first glance, the designing of such a wedge seems quite simple and easily brought about through the placing of a suitably arranged spring underneath the adjusting wedge and operating on it in such manner as to gradually force up the wedge as lost motion develops in the driving box parts. It is understood that this method, without any change in the adjusting wedge other than adding to it of such a spring and the small parts necessary to give the required spring tension, has been tried out on at least one large railroad. In giving this method a second thought, however, we are likely to look for what we understand actually occurs, that of the wedge being gradually tightened until it grips the box, causing a hard riding locomotive and possible rough usage of the rail as a consequence. This, of course, means the curing of one evil at the expense of acquiring another one practically as bad.

A method of preventing this gripping of the box has been brought forward in a self-adjusting wedge now being used to an increasing extent on many of our railroads. In this device the adjusting wedge is made in two parts which might appropriately be referred to as an adjustable wedge and a floating wedge. The adjustable wedge is tapered on one side to suit the taper of the frame jaw with a reverse taper on its opposite face. The floating member is also tapered, its thickest part being at its upper end, and it fits between the adjusting wedge and the driving box. A wedge bolt, attached to the adjusting wedge as usual, passes down through the pedestal binder and has attached to it below the binder the adjusting spring and the parts necessary to give this spring the required tension. The floating wedge is made of such length that when fitted into the driving box jaw, there is not less than 3/16 in. nor more than 5/16 in. clearance or play for it to move up and down between the pedestal binder and the frame. With this arrangement, if the driving box should move up in the frame jaw, there would be a tendency for it to carry the floating wedge with it in case there was any clearance between the top of the floating wedge and the top of the frame jaw. On account of the tapers of the two wedge parts this would tend to bring about a loosening of the driving box between the shoe and wedge. Before this could be effected, however, the small clearance given the floating wedge between the pedestal binder and the top of the frame jaw would bring the top of the floating wedge up against the top of the jaw, checking any further tendency to cause undue freedom of the box as the floating wedge would then be held stationary even if the box continued to rise in the frame jaw. If the driving box should move down in the frame jaw the tendency would be to carry the floating wedge with it and at the same time there would be a tendency to force down the adjusting wedge against the spring tension. This would bring about a loosening of the driving box between the shoe and wedge. The limited clearance space of the floating wedge in the frame jaw, however, would cause the lower end of the floating wedge to strike the binder and prevent further tendency to cause undue freedom of the box, as the floating wedge would then be held stationary even if the box continued its downward movement.

Reports from several of our members located on roads having this device in use and who have had actual experience with it, as well as from several mechanical superintendents on roads having it in use, state that it gives excellent results.

While any type of self-adjusting wedge is supposedly automatic in its action, it must be remembered that none are automatic in maintenance. Like all mechanical devices they require a certain amount of attention, the labor required, for such attention being, of course, considerably less than is necessary for looking after manually adjusted wedges. The principal attention to self-adjusting wedges should be for regular lubrication, absolutely necessary with any type of wedge, and the adjustment of the adjusting spring.

It is impossible to give accurate figures on the savings in cost of upkeep of the frame, box parts and runnings gears as between engines having manually adjusted wedges and ones with self-adjusting wedges for the reason that many troubles with these parts which could be caused by poorly maintained driving box parts might also be due to other causes. However, a table prepared by an eastern railroad shows in a general way results obtained from locomotives of same type with self-adjusted wedges of the type just referred to.

[The table gave in detail the amount of rod work required on 20 locomotives of the 2-10-2 type equipped with the self-adjusting wedges, from July 18, 1920, to January 31, 1921, during which period the engines aggregated 408,447 miles, or slightly more than 20,000 miles each. Four engines, aggregating 83,800 miles, received no rod work whatever. Eight engines, aggregating 161,865 miles, received complete rod work. On the remaining eight locomotives 12 No. 3 brasses, 8 No. 2 brasses, and one set of main bushings were renewed. No crown bearing or wedge material was used. —Editor.]

Feed Water Heaters

From 55 per cent to 58 per cent of all heat generated in the firebox is lost in exhaust steam. This great loss of heat is due to the necessity of exhausting steam from the steam cylinders while still in its gaseous form and to the fact that it requires about 970 heat units simply to hold water in the form of steam, all of which, together with such additional heat units as may be in the exhaust steam, is allowed to pass out of the locomotive stack without doing any additional work other than acting as a draft on the fire.

Considerable success has been achieved in heating feed water for boiler use by means of exhaust steam. It is our understanding that this practice has long been successfully made use of in connection with stationary boilers; also, that it is used to a considerable extent in European countries on locomotives. Germany alone is said to have 10,000 locomotives equipped and to be adding this equipment at the rate of 2,000 feed water heaters per year. That this method has not received more consideration in this country in the past has probably been due to cheap fuel and lack of an efficiently developed device for the object in view.

Generally speaking, feed water heaters making use of exhaust steam are of two kinds known as the closed type and the open type. In the open type the exhaust steam either goes directly into the feed water, and in condensing gives up its heat to the water or goes through tubes surrounded by the feed water, heating this water while being itself condensed in the tubes. When it goes directly into the water it is found advisable to pass the exhaust steam through an oil separator enroute to the feed water heater to prevent lubricating oil contained in exhaust steam from entering the locomotive boiler. In this type the heater is open to atmospheric pressure and the pump is placed between the heater and the boiler check. In the closed type the water is forced through tubes in an enclosed heater, these tubes being surrounded with exhaust steam which heats the water as it passes through the tubes. In this type the heater is between the pump and the boiler check and is subject to boiler pressure.

In the open type on account of the heater being open to atmospheric pressure the feed water can be heated only to the normal boiler temperature of 212 deg. F. In the closed type it is possible to heat the water to within 10 to 15 deg. of the temperature of the exhaust steam, which may run as high as 250 deg. F.

About one-sixth or 15 per cent of the exhaust steam which would ordinarily go out through the locomotive stack is diverted to the use of the feed water heater.

One type of heater which has been applied to probably one-half of the American locomotives so far equipped has an arrangement whereby after the exhaust steam going to the heater has been condensed, this water can be filtered, freeing it of any lubricating oils that it may contain, and be returned either to the locomotive tender or into the suction pipe of the pump carrying the feed water to the heater. By this means it is claimed that the tender water capacity is in effect increased 10 per cent to 15 per cent.

That a large fuel saving and actual increase in boiler efficiency will result from such installation seems to be generally believed. The economical results obtained are due not only to the fact that a large amount of the heat from the exhaust steam is reclaimed, but also because the rate at which the fuel is burned on the grate is reduced.

Our information is that some eighteen of our American railroads are today using or experimenting with feed water heaters, although not to exceed seventy-five locomotives all told are equipped, and that five different types of feed water heaters are being tried out. Owing to the limited number in use and the time used, reliable figures as to the average cost of maintenance of such devices are not available, but it is believed it will be well within the bounds of reason as compared to the savings which it is believed can be brought about by their use.

A summary of a number of runs made with a freight locomotive on the New York division of the Erie Railroad equipped with a feed water heater of the closed type heater, as compared with the same number of runs using the injector, is shown in one of the tables. A summary of nine runs with feed water heater and nine with the injector, in passenger service with a locomotive on the D. L. & W., equipped with the same type of feed water heater, is also shown.

Summary of Erie Railroad Feed Water Heater Tests

Direction of runs	Heater West	Injector West	Heater East	Injector East
Length of runs—miles	88.3	88.59	89.22	89.44
Actual running time—dec. hours	4.75	5.436	5.658	5.699
Number of cars, including dynamometer car	70	74	80	87
Actual tons, including engine and tender	1,957	1,988	5,029	4,943
Coal fired per locomotive mile	211	245	203	241
Average steam pressure	173	172.0	173.1	172.7
Average superheat	579	597	571	600
Maximum superheat	606	641	604	640
Water evaporated per pound coal as fired, running time	7.917	6.867	7.697	6.529
Water evaporated, per lb. dry coal, R. T.	7.965	6.909	7.735	6.609
Equiv. evap. per lb. drv coal, R. T.	9.270	8.070	9.007	7.772
Total coal fired, running time	18,635	21,705	18,151	21,574
B. t. u. per lb. coal as fired	13,279	13,702	13,357	13,225
Boiler efficiency, based on dry coal, per cent	67.34	57.0	65.1	56.3
Coal fired, running time, to operate feed water pump	231	....	225	....
Water evaporation per lb. coal as fired, running time, based on equal B. t. u.'s (13,225)	7.885	6,628	7.621	6.529
Per cent saving in coal as fired, running time, in favor of feed water heater	18.96	....	16.72	....
Per cent total coal fired to operate feed water pump	1.24	.....	1.24	.....
Per cent net saving in coal as fired, R. T. in favor of feed water heater	17.72	....	15.48	....
Average feed water temperature	71	65	71	60
Average temperature of feed water leaving heater	209	....	193	....
Average temperature of feed water leaving injector	....	178	....	169.5
Maximum temperature of feed water leaving heater	231	....	239	....
Maximum temperature of feed water leaving injector	....	199	....	190

Average Results of Nine Tests With and Nine Tests Without Feed Water Heater—D. L. & W. Locomotive 1135, on Train No. 6

.	Heater	Injector	Per cent difference for heater
Tonnage	527	535	1.5 per cent less tonnage
Running time	193	189	2.2 per cent more running time
Total coal, lb.	9,760	12,460	21.6 per cent less coal per run
Total water, lb.	97,919*	95,493	2.27 per cent more water per run
Lb. water per lb. coal	9.97*	7.79	28.0 per cent more water per lb. coal
Coal per ton train	18.4	23.3	21.0 per cent less coal per ton train
Water per ton train	186.	180	1.67 per cent more water, ton train

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* 12 runs.

The Locomotive Booster

The locomotive booster is designed to assist in starting such standing trains as the locomotive is capable of hauling on a level track when once in motion without the aid of such device, but which it would otherwise be unable to start without assistance of some kind and for helping it to haul such trains over ordinary grades encountered between terminals; to assist in starting trains out of places where stops are necessary, as at stations, towers, water plugs, switches, etc., or where made necessary by locomotive or train troubles, and which, on account of curvature or grade, are bad places to start from and ordinarily would require the taking of the train slack, perhaps backing up to a place from which a start could be made, setting off of cars, doubling of grade, or obtaining the assistance of another locomotive.

While the addition of a booster increases the tractive effort of the locomotive and thereby makes possible the starting of additional cars and to that extent serves to increase the tonnage which can be hauled under normal conditions or serves to assist in getting heavy trains over the road without delays on grades and at bad starting places, it is in no sense intended as an aid in permitting the overloading of the locomotive to a point beyond what its normal capacity would be when in motion on a level track without this device, as this would make additional aid again necessary in starting from terminals, bad starting places enroute and on ascending grades.

The method of operation is simple. The engineman decides that he needs the booster, he raises the booster latch, which makes contact with the control valve, and the booster is automatically engaged. The booster cuts out automatically when the reverse lever is moved back from the corner, which is at a speed of approximately 12 to 15 miles an hour, or it may be cut out instantly by the engineman knocking the booster latch down, which is similar to knocking out an electric switch.

The claims made for the booster are that it puts any locomotive with trailing wheels into the next class above in starting effort, because the trailing wheels act as an additional pair of drivers; that on freight trains this means more tons handled annually because of greater starting effort and acceleration, and avoids damage to machinery and equipment because of a smooth, steady start; that on passenger trains it means smooth starting and quick acceleration to road speed, protects the equipment from damage and renders schedules more easily maintained by avoiding delays in starting; that it reduces by one-half the time required to get trains to road speed and that it pays its own fixed and maintenance charges several times in doing this through reduced wear and tear on rods, pins, cross-head keys, tires and other parts of the machinery of the locomotive that would ordinarily be caused by slipping in the effort to start, and that when the train is up to road speed it has no more effect on the locomotive's operation than so much coal on the tender.

The following record of a run made on the West Shore line will give a good general idea of the benefits claimed for the booster as shown in actual performance. Engine 3149 left Ravena with a crew that had no previous experience with the booster and the intention was to determine whether or not the full tonnage of 2,582 to 2,600 could be taken through to Weehawken without the usual reduction to 2,100 tons at Newburgh. The booster was used on all starts as well as on grades at speed.

The first test was at Catskill where water was taken, the water plug being located at the bottom of two grades, the ascending one being .39 per cent. The usual practice was to leave the train at the top of the west grade, cut off and run for water, then come back, hook up and make a run for the other grade. This practice was disregarded and the train was hauled down to the water plug. After taking water the booster was cut in and the train carried over the grade at satisfactory speed. With the booster cut in, 5 miles per hour was quickly gained with the draw-bar pull showing 41,067 lb., and for a distance of 580 ft. the speed increased from 5 to 8½ miles per hour. The booster was then disengaged and the locomotive required to take the load entirely and the draw-bar pull dropped to 33,497 lb., or a difference of

7,570 lb. in favor of the booster. This represented 22 per cent increase in draw-bar pull. The throttle and reverse lever were not touched.

The train continued on to Kingston and at each stop the booster was cut in for starting and showed rapid acceleration. The ruling grade is at Haverstraw, six miles long and an average of .47 per cent. A stop was made for water and the train started with the booster. When the grade was reached the speed was 33 miles an hour. On the grade the first mile showed a speed of 28½ miles an hour; the second mile a speed of 19 miles an hour, the third mile a speed of 12 miles an hour, the fourth mile a speed of 8 miles an hour, and the fifth mile a speed of 7½ miles an hour.

Speed was falling very rapidly and at the end of the fifth mile the draw-bar pull registered 36,441 lb. The booster was then engaged where the grade was .52 per cent and in 432 ft. the speed was 8 miles an hour and the draw-bar pull 42,900 lb., a difference of 6,459 lb. or 17 per cent increase with the booster. The speed then gradually rose and reached 10 miles an hour in the next ¾ mile and with tonnage of 22.6 per cent over the previous capacity of the locomotive. One and five-eighths miles of grade yet remained and when the train passed over the top the draw-bar pull showed 45,080 lb. The booster was then cut out and the train arrived at Weehawken with the original tonnage of 22.6 per cent more than this class engine had ever before taken through. A day or so later the regular crew caught engine 3,149 and, not to be outdone by the test just related, brought through 2,618 tons, representing an increase of 24.6 per cent over the ruling tonnage.

The report is signed by T. F. Howley (chairman), Erie; Frederick Kerby, B. & O.; J. P. Stewart, A. T. & S. F.; John Draney, D. L. & W., and J. A. Talty, Franklin Railway Supply Company.

Discussion

The discussion of the self-adjusting wedge indicated that there had been little experience with locomotives having complete installations of the device among the members present. In most cases mentioned the wedges were applied on the main drivers only. The opinion was expressed, however, that to get the full benefit of the device it must be applied on all boxes and this general application seems now to be the tendency. In caring for self-adjusting wedges the most important point, according to the experience on the New York Central, was stated by J. H. De Salis to be the proper attention to the adjustment of the springs. If these are too loose the piston force at full stroke is sufficient to force the wedge down against the spring. If the spring is too tight a stuck wedge results. These difficulties are avoided by keeping the spring adjusted to a height of 1½ in. from the jam nut to the binder. The experience of those taking part in the discussion indicates a material increase in the mileage obtained from driving boxes and better rod conditions than have been obtained with the manually adjusted wedges.

In discussing the feed water heater, J. N. Clark (Southern Pacific) stated that this company has two open type and two closed type heaters in service, one each in a bad water district and one each in a good water district. The results obtained from these installations are, however, not yet available.

In the discussion of the locomotive booster, a number of installations of this device were mentioned, all of which have demonstrated their ability to effect considerable improvement in the handling of heavy trains. W. H. Corbett stated that the Michigan Central has three boosters in service on passenger locomotives, which have eliminated jerking and the necessity for taking slack in starting heavy passenger trains and have materially increased the rate of acceleration in starting these trains up to about eight miles an hour.

A trial on the Chicago & Eastern Illinois was referred to in which a 4,383 ton train was taken over a grade, over which, without the booster with the same locomotive it was required to reduce the tonnage to 3,976. With the booster the heavier train was pulled up the grade in 19 minutes, while the light train without the booster required 23 minutes to move over the same distance.

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The Effect of the Feed Water Heater on Superheat and Back Pressure

BY E. A. AVERILL

PRIMARILY the feed water heater is purely a device for improving the action of a boiler, but when it is applied to a locomotive where the action of the boiler and engines is closely interwoven, it will also have some effect on the action of the steam in the cylinders. This effect is of two kinds; one beneficial; viz., the reduction in the back pressure on the piston, and the other detrimental; viz., the reduced superheat of the steam going to the cylinders.

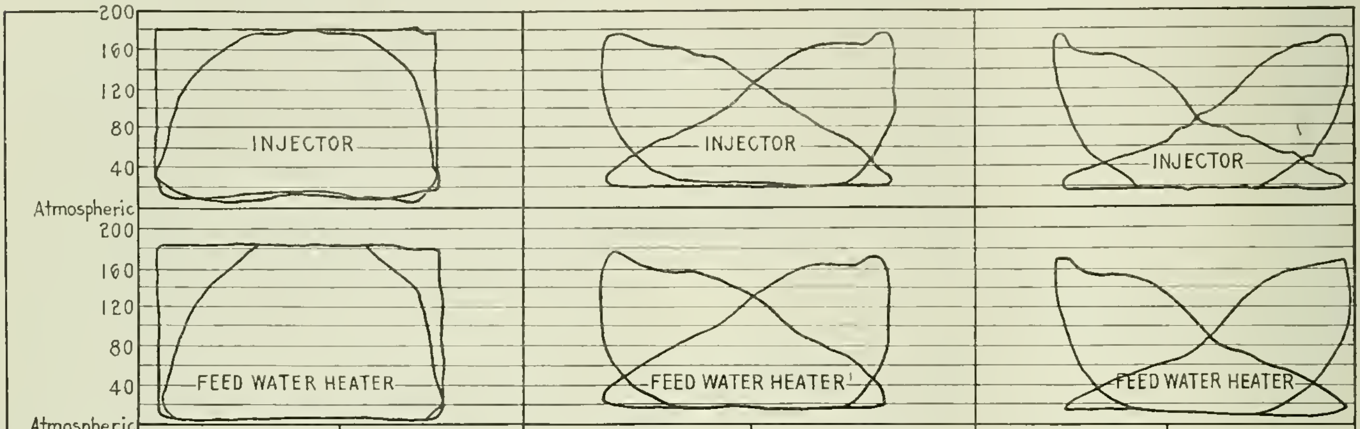
In all locomotives the exhaust steam passage is restricted at the nozzle tip. Thus with a definite amount of steam to be discharged from the cylinders, and the pistons moving at any selected speed, the pressure created in the cylinder back of the piston during exhaust, generally termed the back pressure, has a direct relation to the size of the tip. The smaller the tip the greater the back pressure and vice-versa.

When a feed water heater is applied to a locomotive there are two additional large openings made in the exhaust passages, which combined frequently equal the area of the tip itself. These, however, are connected to the shell of the heater which is in the form of a drum having a relatively small outlet that is water sealed. When the feed water heater is not in operation this drum is filled with exhaust steam, but little can escape and there will be no effect on the back pressure or draft. When, however, cold water is passing through the tubes of the heater, the steam in the heater body is condensed, thus reducing its volume about 1,200 times, and more steam rushes in to take its place. In this way, when the heater is in use, about 12 per cent of the exhaust steam from the cylinders is drawn off before it gets to the nozzle tip. This has somewhat the same effect as an increase of the same percentage in the size of the tip or a change in diameter from 6 in. to 6 5/16 in.

Naturally this increased opening means a reduction in the back pressure on the piston which in turn means increased power from the same amount of steam admitted to the cylinders. In order to determine just how great this increase in power might be, arrangements were made during a recent test of feed water heaters to obtain as nearly as possible the same speed and the same cut off at selected points on the run with and without the feed water heater. Indicator cards were taken at these places and as the boiler pressure was the same in all cases, exactly the same volume of steam entered the cylinder. Calculation of the indicated horsepower from the cards gave the desired information. Several sets of these cards are shown in the illustration.

It is readily seen from the appearance of the cards how much the back pressure was reduced by the heater. It is particularly interesting, in the low speed card, to note how the hump caused by the exhaust from the other side of the engine, has been smoothed out when the heater was in use.

Under each pair of cards will be found a table giving the conditions and the indicated horsepower developed, as well as the percentage of increase shown by the feed water heater. In the first pair of cards, because of an eight per cent difference in the speed, the comparisons are made on the basis of mean effective pressure. In the others the speeds are practically the same and the comparison is made on the basis of indicated horsepower.



	FEED WATER HEATER	INJECTOR	FEED WATER HEATER	INJECTOR	FEED WATER HEATER	INJECTOR
CUT-OFF	74.5 %	74.5 %	53.7 %	53.7 %	40.1 %	40.1 %
SPEED	10.1 M.P.H.	10.9 M.P.H.	35. M.P.H.	36. M.P.H.	43. M.P.H.	43. M.P.H.
M.E.P.	164. LB.	158.85 LB.	98.35 LB.	87.6 LB.	77.5 LB.	73.5 LB.
I.H.P.	1305. H.P.	1361. H.P.	2745. H.P.	2583 H.P.	2719. H.P.	2555. H.P.
INCREASE	5.15 LB.(M.E.P.)		162. H.P.		164. H.P.	
PER CENT	3.25 %		6.3 %		6.4 %	

Comparative Indicator Cards With and Without the Feed Water Heater

It will be seen that the effect of the feed water heater has been to increase the horsepower developed by over six per cent at the highest speed, and over three per cent at the lowest speed. With exactly the same volume of steam entering the cylinder in each case the feed water heater increases the power by three to six per cent because of the lower back pressure.

This, of course, is very satisfactory, but further investigation of the conditions should be made before the final conclusion is reached. While the same volume of steam entered the cylinders when these cards were taken, it was not at the same temperature in both cases and thus did not weigh the same per cubic foot. The steam with the feed water heater in use was not as highly superheated, and this condition must be taken into consideration.

A feed water heater will generally reduce the coal consumption for the same quantity of steam delivered from the boilers by from 13 to 15 per cent. This means that if the boiler without the heater will evaporate eight pounds of water per pound of coal, it will evaporate from 9.04 to 9.20 lb. of water with the heater in use. Thus the superheater, while passing the same quantity of steam through the units, is supplied with about 15 per cent less hot gas than before. Naturally without changing the superheater, the steam will not be as highly superheated as when the heater was not in use, and more coal was being burned to produce each pound of steam that passes through the units.

Data to determine just how large this drop in superheat may be is easy to obtain and has been taken on a number of tests. On the test mentioned above the average loss of superheat amounts to about 22 deg. F. Under conditions on other tests it has been found to vary between 20 and 30 deg. F.

The reduction in superheat by 22 deg. F. means an increase of about two per cent in the weight of steam per cubic foot under the conditions on these runs. Since the cut off with and without the heater was identical, and the speed was alike, essentially the same volume of steam entered the cylinders in both cases.

Making the correction for the greater weight of the steam per cubic foot it will be found that there is a reduction of about four per cent in the pounds of steam per indicated horsepower when the feed water heater was in use over that used with the injectors. This, then is the net effect of a feed water heater on the cylinders and clearly indicates that there is a gain in over all efficiency from this source in addition to the large gain obtained by the direct effect on the boiler.

Of the Total Railway Mileage in the United States rather over 1 per cent is operated electrically as against about 4 per cent in Britain.—*South African Railways & Harbors Magazine.*

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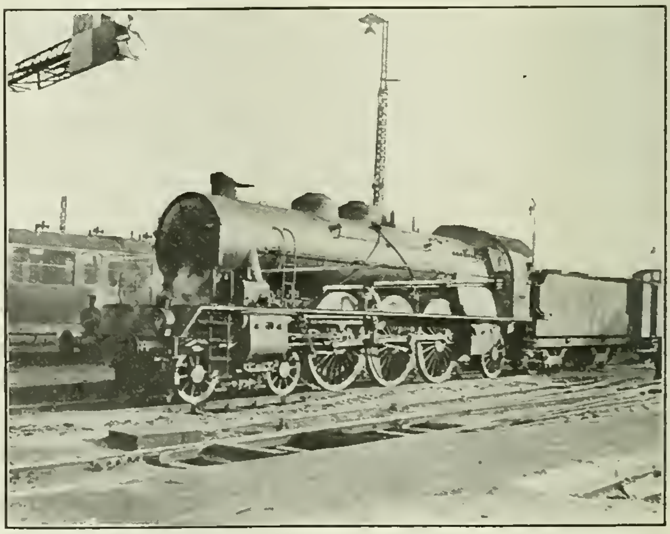
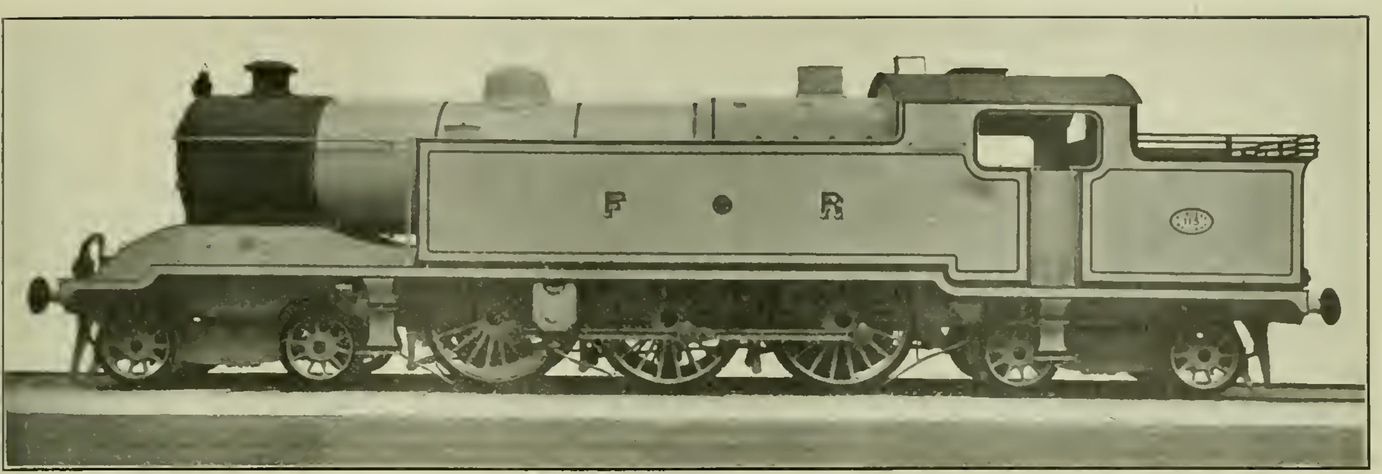


Pacific Type Locomotive on the Paris, Lyons and Mediterranean



Heavy Tank Locomotive of 4-6-4 Type for Furness Railway; Built by Kitson and Company, Leeds, 1920

The Comparison of Dimensions and Proportions of British Locomotives

BY E. C. POULTNEY

PART TWO

IN the first section of this article, which appeared in the September issue of the Railway Mechanical Engineer, Mr. Poultney discussed the factors used in comparing various types and designs.

General Considerations

When comparing the dimensions of locomotives of various types and considering the abilities of their boilers to supply the power required as expressed by Boiler and Boiler Demand Factors, it is necessary to consider not only the relationship existing between the cylinder horsepower and the total evaporative heating surfaces, but also the disposition of the heating surfaces and also the ratio of proportion which the grate area bears to the total evaporative surface, and in the case of superheater locomotives the evaporative surface and that contributed by the superheater elements. The evaporative heating surface of a locomotive boiler is made up of two parts, the tube and the fire-box surfaces, and of these the surface of the fire-box is per unit of area the most valuable. This being so, it follows that if two boilers are compared, one having a larger fire-box than the other but each having equal total heating surfaces, and grate areas, the boiler having the larger percentage of its total surface contained in the fire-box will give the higher evaporation and for equal engine efficiencies will develop a higher horsepower per square foot of heating surface. Further, if two boilers each having equal tube and fire-box heating surfaces, but having different grate areas so that they differ by having different values of *C*, then at equal rates of firing the boiler having the larger grate will evaporate more water per square foot of heating surface per hour than the boiler having the smaller grate; it will not, however, be so economical; in other words, the water rate per pound of fuel fired will not be so great as with the boiler having the relatively small grate surface. The boiler having the larger grate will, however, permit of higher *B* and *BD* factors.

From the foregoing it would seem that when considering the boiler factors *B* and *BD* the proportion of the total heating surface that is contributed by the fire-box should be considered, and also the value of the factor *C*. When examining the boiler factors for different locomotive types it will at once be noticed that in cases where the power demand per square foot of heating surface is high, as shown by the value of the factors *B* and *BD*, the grate areas used are always large in proportion to the heating surfaces, and further, fire-box surfaces are usually larger in proportion to the total heating surfaces.

The higher values for $\frac{\text{FBS}}{\text{St.}}$ are in almost all cases accompanied by a lower value for *C*, indicating a large grate.

Generally, a larger grate surface will mean at the same time a larger fire-box because for any given type or form of fire-box any increase in the dimensions of the grate will naturally result in a longer or a wider box which will, if the height remains unaltered, result in a larger heating surface. The ratio of proportion between the grate area and the firebox surface has already been mentioned, and its importance lies in the fact that on it depends the volumetric capacity of the fire-box as expressed by the $\frac{\text{FBS}}{\text{GA}}$ factor.

Tables of Dimensions and Proportions

Turning now to the tables of dimensions and proportions it will be noticed that a considerable number of locomotive types are covered.

Table 1—4-4-0 type Express engines—contains particulars of 17 different locomotives for 11 different railways; thus the idea of several designers can be seen. The examples are all modern designs, that is, they have been built new, or rebuilt with superheaters during the last ten years, and the same applies to the locomotives listed in the remaining tables.

As will be seen, 17 different items of information are given. The first is the name of the road, then follow 10 columns giving the principal dimensions, and the remaining 6 show how the related dimensions are proportioned to each other, and seem to be sufficiently comprehensive to enable the making of a comparative study of each different design.

The locomotives shown in Table 1 cover a wide range of

TABLE 1.

Eight-Wheeled—4-4-0 Type Locomotives

Railway	Total weight Wt.	Adhesive weight AW	Cylinders dia.; and stroke, in. d s	Drivers dia. in. D	Steam pressure P	Rated tractive effort RTE	Total heating surface evaporative S	Superheater surface Sh	Total heating surface St	Grate area GA	Fire-box surface per cent of total FBS/St	Superheater surface, per cent of total SH/St	Adhesive weight / Rated tract. effort A	R.T.E. × D / Total heating surface evaporative BD	Total heating surface / Grate area C	Total weight / Total heating surface E
L. N. W............	133,840	85,120	20½x26	81	175	20,000	1,547.7	302.5	1,850.2	22.4	8.3	16.4	4.27	1,045	82.6	72.2
G. C. R............	136,600	88,500	20 x26	81	180	19,800	1,659	210	1,869	26	8.4	11.2	4.46	980	72.0	73.0
N. E. R............	133,100	91,600	19 x26	82	160	15,600	1,058.8	390.7	1,449.5	27	10.9	26.9	5.86	1,210	53.7	91.9
L. C. D. S. E......	128,700	84,500	20½x26	80	160	19,100	1,412	319	1,731	22.5	9.2	18.4	4.42	1,080	76.5	74.3
C. R...............	137,200	89,040	20½x26	78	180	21,432	1,329	200	1,529	20.7	9.4	13.1	4.15	1,260	74.0	89.7
C. R...............	137,200	88,816	20 x26	78	170	18,200	1,329	226	1,555	20.6	9.2	13.9	4.87	997	75.5	88.4
M. R...............	119,588	77,169	19½x26	84½	175	17,200	1,172	313	1,485	21.1	7.5	21.1	4.48	1,240	70.3	80.5
M. R...............	134,963	87,360	19 x26	78½	200	21,400	1,321	360	1,681	28.4	8.4	21.4	4.07	1,175	59.3	80.3
L. S. W. R..........	135,336	80,724	20 x26	79	180	20,000	1,284	231	1,515	27.0	9.6	15.2	4.03	1,232	56.1	89.5
G. W. R............	123,872	80,864	18 x26	80½	200	17,900	1,352	215	1,567	20.5	8.2	13.7	4.51	1,065	76.4	78.5
L. & Y.............	107,856	74,032	20 x26	87	160	18,300	886.1	209.9	1,096	18.75	9.9	19.1	4.06	1,795	58.4	98.2
L. C. D. S. E......	117,700	75,000	19 x26	78	180	18,700	1,277.9	228.0	1,504.9	24.0	8.4	15.1	4.02	1,141	62.7	78.3
G. N. R............	120,000	......	18½x26	80	160	15,070	972	258.0	1,230	19.0	9.75	21.0	....	1,240	64.7	97.5
N. B...............	129,600	84,900	20 x26	78	180	20,400	1,285.5	355.2	1,640	21.1	8.5	21.6	4.1	1,237	75.7	79.0
G. W. R............	127,300	84,200	18 x30	8½	200	20,600	1,478	212.5	1,690	20.5	7.6	12.5	4.1	1,112	82.4	75.4
N. E. R............	123,100	80,000	19 x26	82	175	16,940	1,120	306	1,426	20.5	10.1	21.4	4.8	1.242	71.3	86.3
G. C. R............	124.700	81.200	19 x26	81	180	17.584	1,275	179	1,454	21.0	9.3	12.3	4.6	1,116	69.3	85.6
											8.8	16.7	4.25	1,126	70.0	82.7

TABLE 2

Ten Wheeled—4-4-2 Type Locomotives

Railway	Total weight Wt.	Adhesive weight AW	Cylinders dia.; and stroke, in. d s	Drivers dia. in. D	Steam pressure P	Rated tractive effort RTE	Total heating surface evaporative S	Superheater surface Sh	Total heating surface St	Grate area GA	Fire-box surface per cent of total FBS/St	Superheater surface, per cent of total SH/St	Adhesive weight / Rated tract. effort A	R.T.E. × D / Total heating surface evaporative BD	Total heating surface / Grate area C	Total weight / Total heating surface E
N. E. R............	172,800	89,300	16½x26*	82	175	19,161	1,475.8	530	2,005.9	27.0	8.9	26.4	4.6	1,063	74.0	85.7
G. N. R............	156,256	80.520	20 x24	80	170	17,300	2,027.0	570	2,597	30.9	5.5	28.1	4.6	690	83.6	60.2
L. B. S. C..........	152,800	83,400	20 x26	79½	170	20,800	2,031.0	460	2,491	30.9	5.4	18.5	3.9	815	80.5	61.3
N. B...............	171,900	89.400	21 x28	81	180	23,400	1,803.8	385	2,188.8	28.5	8.4	17.6	3.8	1,051	76.7	78.5
G. N. R............	134,400	72,600	20 x24	80	170	17,300	1,163.0	254	1,417	24.5	9.6	17.9	4.2	1.186	57.8	95.0
N. E. R	167,300	86,400	20 x28	82	175	20,214	1,475.8	530	2,005.9	27.0	8.9	26.4	4.2	1,123	74.0	83.5
											7.8	21.5	4.2	967	74.4	77.3

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*Three cylinders.

Side Tank Engines

Railway	Total weight Wt.	Adhesive weight AW	Cylinders dia.; and stroke, in. d s	Drivers dia. in. D	Steam pressure P	Rated tractive effort RTE	Total heating surface evaporative S	Superheater surface Sh	Total heating surface St	Grate area GA	Fire-box surface per cent of total FBS/St	Superheater surface, per cent of total SH/St	Adhesive weight / Rated tract. effort A	R.T.E. × D / Total heating surface evaporative BD	Total heating surface / Grate area C	Total weight / Total heating surface E
L. B. S. C..........	163.720	85,120	21 x26	79½	160	19,580	976	305	1,281	24.0	9.8	21.3	4.3	1,595	53.3	....
G. W. R............	16,800	82.880	18 x30	80½	195	19,950	1,029	185	1,214	20.5	10.0	15.2	4.1	1,560	59.2	....
N. S. R............	......	......	20 x26	72	160	19,630	1,020	261	1,281	21.0	10.7	20.3	...	1,387	61.0	....
											10.2	19.0	4.2	1,517	57.8	....

TABLE 2A

12 Wheeled 4-4-4 Type Locomotives

Side Tank Engines

Railway	Total weight Wt.	Adhesive weight AW	Cylinders dia.; and stroke, in. d s	Drivers dia. in. D	Steam pressure P	Rated tractive effort RTE	Total heating surface evaporative S	Superheater surface Sh	Total heating surface St	Grate area GA	Fire-box surface per cent of total FBS/St	Superheater surface, per cent of total SH/St	Adhesive weight / Rated tract. effort A	R.T.E. × D / Total heating surface evaporative BD	Total heating surface / Grate area C	Total weight / Total heating surface E
N. E. R............	189,840	89,600	16½x26*	69	160	20,800	1,058	273	1,331	23	9.3	20.5	4.3	1,351	57.8	....
Met. R.	172,800	87,400	19 x26	69	160	18,430	1,178	268	1.446	21.4	9.1	18.5	4.7	1,079	67.5	....
											9.2	20.0	4.5	1,215	62.6	....

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*Three cylinders, simple expansion.

TABLE 3

Ten Wheeled—4-6-0 Type Locomotives

Railway	Total weight Wt.	Adhesive weight AW	Cylinders dia.; and stroke, in. d s	Drivers dia. in. D	Steam pressure P	Rated tractive effort RTE	Total heating surface evaporative S	Superheater surface Sh	Total heating surface St	Grate area GA	Fire-box surface per cent of total FBS/St	Superheater surface, per cent of total SH/St	Adhesive weight / Rated tract. effort A	R.T.E. × D / Total heating surface evaporative BD	Total heating surface / Grate area C	Total weight / Total heating surface E
L. & N. W. R....	174,300	133,200†	15¾x26	81	175	23,800	1,748.7	379.3	2,128.0	30.5	8.1	17.8	5.6	1.093	69.8	81.9
G. C. R..........	168,560	126,360	21½x26	81	180	22,750	2,386	440.0	2,826	26	5.9	15.5	5.5	773	108.6	59.5
G. C. R..........	177,000	128,000†	16 x26	81	180	24,772	2,044	343	2,387	26	6.8	14.3	5.1	980	92	74.0
C. R.	165.556	124.736	20½x26	78	175	20,600	1,818	515	2,332	26	6.3	22.0	6.0	836	89.6	71.0
G. E. R..........	143.360	97,560	20 x28	78	180	22,000	1,623	286 4	1,919	26	7.4	14.9	4.4	1,057	73.8	74.7
G. W. R..........	169.300	124,100†	15 x26	80½	225	27,800	1,841.3	283.4	2,124.7	27	7.2	13.3	4.4	1,212	78.7	79.5
G. W. R..........	169,300	124,100†	14¼x26	80½	225	25,100	1,841.3	283.4	2,124.7	27	7.2	13.3	4.9	1,095	78.7	79.5
L. N. W. R......	148,400	94,720	20½x26	75	175	21,000	1,572.9	324.5	1,897.5	25	7.0	18.5	5.4	1,000	73.5	78.0
G. S. W. R. 1....	158.368	115,136†	14 x26	79	175	18,900	1,772	440	2,212	28	7.1	20	6.0	845	78.0	71.0
L. & Y..........	177.100	132,700†	16½x26	75	180	29,000	1,995	552	2,547	27	6.8	21.6	4.5	1,120	94.5	69.6
N. E. R..........	158 368	120,176	20 x26	73½	160	19,200	1,821	544	2,365	23	6.08	23.0	6.2	775	103.0	66.9
N. E. R..........	174,100	131.488*	18½x26	68	180	30,032	1,573	530	2,103	27	7.9	26.4	4.3	1,300	77.5	83.2
L. S. W. R......	174,300	125,100	21 x28	67	180	28,200	1,878	308	2,186	30	7.4	14.1	4.4	1,000	72.7	79.7
C. R.	168,000	126,560	20 x26	73	175	21,155	1,676	258.2	1,934	25.5	7.5	13.3	6.02	922	75.7	86.8
C. R.	181,500	134,400*	18½x26	73	180	28,000	2,370	270	2,640	28.0	6.4	10.2	4.8	864	94.2	68.8
G. W. R.........	161.000	123,000	18½x30	80½	225	24,200	1,841.3	283.4	2,124.7	27	7.2	13.3	5.0	1,055	78.7	75.7
L. S. W. R.......	174.500	125.300	22 x28	79	180	25,200	1.878	308	2,186	30	7.4	14.1	4.9	1,060	73.0	80.0
											7.5	16.8	5.1	1,000	80.0	75.7

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†Four cylinders simple expansion. *Three cylinders simple expansion.

power. The rated tractive effort varies from a minimum of 15,070 to a maximum of 21,432 lb. It will be noticed that for locomotives having the higher boiler demand factors the combustion factor is usually high, and the amount of heating surface provided by the fire-box is usually somewhat greater, thus indicating high evaporative possibilities from the heating surface. Several examples of 4-4-0 engines have been given because this is a very much used type. It is comparatively simple in construction, and can be built to develop up to about 1,100 hp. where axle loads of 43,000 lb. and a total weight of about 135,000 lb. are allowed, and in its larger sizes the weight is low compared with the power available.

TABLE V

Comparative Proportions of Typical Main Line Tender Engines Using Superheated and Saturated Steam

	Type	B.D.F.	C	F.B.S St.	F.B.S. G.A.	R.T.E G.A.	A	E	Reference
Superheated...	4-4-0	1,126	70	8.8	6.2	828	4.25	82.7	Table I
Saturated......	4-4-0	918	72.5	8.5	6.0	830	4.3	75.3	" IV
Superheated...	4-4-2	967	74.4	7.8	5.7	704	4.2	77.3	" II
Saturated......	4-4-2	717	77.7	6.9	5.5	700	4.3	67.2	" IV
Superheated...	4-6-0	1,000	83.0	7.5	5.8	890	5.1	75.7	" III
Saturated......	4-6-0	833	79.4	7.1	5.4	884	5.2	76.3	" IV
Superheated...	0-8-0	1,097	81.5	7.9	6.3	1,250	4.8	68.6	" V
Saturated......	0-8-0	874	80.7	7.9	6.0	1,290	4.5	72.4	" IV
Superheated...	0-6-0	1,103	70.5	9.0	6.1	1,160	4.6	80.0	" VII
Saturated......	0-6-0	980	64.8	8.9	5.9	1,020	4.7	76.2	" IV

The Atlantic or 4-4-2 type express locomotives and tank engines for local passenger service having this wheel arrangement are shown in Table 2. Probably the two most interesting examples are the North Eastern three-cylinder and the Great Northern two-cylinder engines. They both handle trains of the same weight at similar speeds, and each have the same factor *A* but differ materially in other characteristics. The writer has traveled on engines of each design, and they are excellent steamers.

The North Eastern locomotive has a larger fire-box in proportion to the total heating surface, and the factor *C* is 11 per cent less. The North British (N.B.R.) locomotives are in point of actual maximum tractive force, the most powerful of their type; they are remarkably fine engines and are used for all the heaviest express services.

The 4-4-2 tank engines each have high boiler demand factors for reasons already stated. The fire-box surface is, however, comparatively large, and here again the factor *C* has a low value, indicating relatively larger grate areas.

Table 2A shows two examples of somewhat large four coupled tank engines for heavy local services. They are the only examples available having this wheel arrangement.

During recent years six coupled engines have come much to the fore in heavy main line passenger traffic. Table 3 gives 17 examples covering the practice followed on 9 different railways. The R.T.E. covers a range of power from 18,900 to 30,000 lb., the latter being a powerful design of 3-cylinder 4-6-0 engine recently built for express goods traffic on the North Eastern (N.E.R.).

The first example in the table is a powerful class of engine used in heavy express service on the London & North Western. These engines can maintain 1,400 i.hp. Another powerful type is shown by the third example. This is a four cylinder engine, several of which are now running on the Great Central (G.C.R.) and yet another is shown in the seventh example. This is a four cylinder type of which a number are in use on the Great Western. The writer has observed the working of each of these different designs from the footplate. They are good steamers and ride splendidly.

The Caledonian Railway three-cylinder engine is not at the time of writing in service. The weights given are therefore estimated.

Tables 4 to 7 inclusive, give the comparative particulars of goods or freight traffic engines.

The Midland 0-10-0 locomotive is interesting as being the only engine of its type. These locomotives have recently been built more particularly for pusher service on the famous Lickey incline of 1 in 37 (2.7 per cent) on the Midland West of England main line. Those conversant with history will recollect that when this line was first opened Norris & Co. of Philadelphia supplied some engines specially to work on the Lickey gradient.

Eight-wheeled engines of the 2-6-0 type have been introduced on some lines for freight service, and Table 6 begins by giving particulars of three different classes introduced on the Great Northern (G. N.). They illustrate three successive steps in the development of this particular type in which the weight per square foot of heating surface has been reduced from 103 to 69 lb., and the R.T.E. increased from 23,350 to 30,000 lb. The engines have been very successful, especially the larger three-cylinder series.

Table 8 contains engines having the 4-6-2 wheel arrangement. The G.W.R. engine shown is the only Pacific type tender engine running in Britain. The grate surface of 41 square feet is obtained by using a wide fire-box. The other examples are all tank engines for local passenger services.

Table 10 contains only one locomotive, a 4-6-4 type tank engine introduced for express passenger service on the London, Brighton & South Coast Railway. Two are in traffic and others are under construction.

In order that the more modern superheated steam locomotives may be compared with those using saturated steam, Table IV has been prepared in which the proportions of 31 main line engines are analyzed. The average results obtained are tabulated for comparison with the superheater locomotives in Table V, in which the $\frac{FBS}{GA}$ and $\frac{RTE}{GA}$ factors have been added as additional information.

Naturally, the value of $\frac{RTE}{GA}$ for any given locomotive will directly depend on the *BD* and the factor *C*, and the actual value of $\frac{RTE}{GA}$ has only been added here so that its average actual value can be shown.

Table V, giving the comparative proportions of certain typical main line locomotives should have a little attention in conclusion. Only the 4-4-0, 4-4-2, 4-6-0, 0-8-0 and 0-6-0 types are here considered.*

The interesting characteristic for the modern superheaters is the value of the boiler factor *BD*. This is seen to be from 17 to 25 per cent higher than the average for the engines using saturated steam.

The tractive effort of modern superheated engines is generally greater than that of the older saturated steam engines, and the following comparative statement will be of interest on this point.

Comparative R.T.E. Superheated and Saturateo Steam Engines

	Average values maximum tractive effort (R.T.E.)	
Engine type	Superheated	Saturated
4-4-0	18,700 (17)	17,800 (9)
4-4-2	19,700 (8)	19,300 (6)
4-6-0	24,000 (17)	22,950 (8)
0-8-0	30,860 (5)	29,200 (6)
0-6-0	23,700 (7)	19,000 (10)

Note.—The small figures in parentheses indicate the number of engines examined.

Table IV, in which the ratios of proportions of representative saturated steam using locomotives are given, has been prepared so as to give detail information as to the practice followed in the design of saturated steam locomotives, and also to enable comparisons to be drawn between saturated and superheated engines for main line service.

The 4-6-0 type locomotives shown have wheels from 62

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*There were very few 2-8-0 and 2-6-0 type locomotives in service before the introduction of superheaters.

to 80 in. diameter, and the R.T.E. varies from 27,000 to 18,600 lb. In Table 3 superheated locomotives the R.T.E. varies from 30,000 to 18,900 lb. and further, the R.T.E. of 11 out of the 17 examples is over 22,000 lb.

This increase in rated tractive effort has carried with it a corresponding increase in the heating surfaces, so that the modern superheated locomotives show a slightly better factor *E* than the older and smaller saturated steam engines.

TABLE 4

TEN-WHEELED—2-8-0 TYPE LOCOMOTIVES

Railway	Total weight	Adhesive weight	Cylinders dia.; and stroke, in.	Drivers dia. in.	Steam pressure	Rated tractive effort	Total heating surface evaporative	Superheater surface	Total heating surface	Grate area	Fire-box surface per cent of total	Superheater surface, per cent of total	Adhesive weight / Rated tract. effort	R.T.E. × D / Total heating surface evaporative	Total heating surface / Grate area	Total weight / Total heating surface
	Wt.	AW	d s	D	P	RTE	S	Sh	St	GA	FBS / St	SH / St	A	BD	C	E
G. N. R.	171,100	149,100*	18 x26	56	170	32,600	2,080.5	430.5	2,521	27.5	6.4	17.0	4.5	880	91.6	67.8
G. N. R.	170,688	150,080	21 x28	56	170	31,750	2,084	570	2,654	27	6.1	21.1	4.7	850	77.3	64.3
G. C. R.	161,280	....	21 x26	56	170	29,500	1,691	318	2,009	26	7.6	15.3	...	977	77.1	80.2
G. C. R.	170,240	154,560	21 x26	56	180	30,814	1,815	308	2,123	26	8.1	14.5	4.9	952	81.7	80.0
G. W. R.	152,996	138,660	18½x30	55½	225	35,200	1,841.3	286.6	2,127.9	27	7.2	13.4	3.9	1,060	79.0	71.7
S. D. J. R.	135,030	125,496	21 x28	55½	190	36,360	1,321	360	1,681	28.4	8.9	21.4	3.3	1,525	59.0	80.3
G. W. R.	174,800	156,300	19 x30	68	225	30,600	1,841.3	330	2,171.4	27.0	7.1	15.2	5.1	1,129	80.3	80.5
											7.3	16.9	4.4	1,053	77.9	74.9

TABLE 4A

TEN-WHEELED—0-10-0 TYPE LOCOMOTIVES

M. R.	164,900†	164,900†	16¾x28	55½	180	43,312	1,718.2	445	2,163.2	31.5	7.3	20.6	3.8	1,400	68.8	76.0

TABLE 5

EIGHT-WHEELED—0-8-0 TYPE LOCOMOTIVES

N. E. R.	147,650	147,650	20 x26	55¼	175	27,985	1,370	544	1,915	23.0	7.5	28.4	5.2	1,127	83.3	60.0
N. E. R.	160,380	160,380*	18½x26	55¼	180	36,960	1,573	530	2,103	27	7.9	26.4	4.3	1,295	77.5	76.2
L. N. W. R.	134,000	134,000	20½x24	53½	160	27,800	1,772.4	378.6	2,151.0	23.6	6.8	17.6	5.1	840	91.0	61.6
L. & Y.	149,128	149,128	21½x26	54	180	34,000	2,063	396	2,459	25.6	7.9	16.1	4.3	890	96	60.7
G. N. R.	124,900	124,900	21 x26	56	160	27,700	1,164	307	1,471	24.5	9.3	20.8	4.5	1,335	60	84.8
											7.9	21.8	4.7	1,097	81.5	68.6

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*Three cylinders, simple expansion.

†Four cylinder simple expansion locomotive specially built for banking or pusher services.

The remarks made regarding the 4-6-0 type apply also to the freight engines of the 0-8-0 type, the increased size of the superheated engines being reflected in the smaller factor *E*. It will be noticed that the largest difference in rated tractive effort is shown by the 4-6-0 type locomotives. The reason is that prior to the advent of superheating, this particular type of engine was not so largely used, and such when employed were generally less powerful than the modern superheaters.

On the other hand, the rated tractive effort of superheated and saturated steam engines of the 4-4-0 type is much the same, showing little increase for recent superheated designs. This is due to the fact that in many instances this class had already been built up to the limits imposed by allowable weights, and therefore when superheated such engines were not materially increased in power, but more economical working attained from the fact that the same or slightly greater power was obtained from an evaporative heating surface about 20 per cent less than that used by saturated steam locomotives of similar size.

TABLE 6

EIGHT WHEELED—2-6-0 TYPE LOCOMOTIVES

Railway	Total weight	Adhesive weight	Cylinders dia.; and stroke, in.	Drivers dia. in.	Steam pressure	Rated tractive effort	Total heating surface evaporative	Superheater surface	Total heating surface	Grate area	Fire-box surface per cent of total	Superheater surface, per cent of total	Adhesive weight / Rated tract. effort	R.T.E. × D / Total heating surface evaporative	Total heating surface / Grate area	Total weight / Total heating surface
	Wt.	AW	d s	D	P	RTE	S	Sh	St	GA	FBS / St	SH / St	A	BD	C	E
G. N. R.	138,200	115,900	20 x26	68	180	23,350	1,118	229.5	1,347.5	24.5	10.1	17.0	4.9	1,423	55.0	103.0
G. N. R.	144,200	118,500	20 x26	68	180	23,350	1,629.5	305	1,934.5	24 0	7.8	15.7	5.1	988	80.6	74.6
G. N. R.	160,800	134,400*	18½x26	68	180	30,000	1,901	407	2,308	28.0	7.9	17.7	4.5	1,055	82.3	69.6
L. B. S. C.	142,240	123,648	21 x26	66	170	25,800	1,295	279	1,574	24.8	8.8	17.7	4.8	1,315	63.5	90.3
G. S. W. R.	139,000	122,784	19½x26	60	180	23,700	1,491	211	1,702	26.2	8.6	12.4	5.1	953	65.0	81.6
G. W. R.	138,900	120,100	18½x30	68	200	25,700	1,478.3	212.5	1,690.9	20.5	7.6	12.5	4.6	1,183	82.5	82.0
S. E. C. D. R.	131,936	112,896	19 x28	66	200	25,700	1,525.6	203	1,728.6	25	7.8	11.6	4.3	1,112	69.3	76.3
C. R.	122,700	104,332	19½x26	60	160	19,424	1,189	266.9	1,455.9	20.6	8.1	18.2	5.3	981	72.0	84.2
											8.1	15.3	4.2	1,112	72.4	82.3

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*Three cylinders—simple expansion.

TABLE 7

SIX WHEELED—0-6-0 TYPE LOCOMOTIVES

G. C. R.	116,600	116,600	18½x26	62	180	21,620	1,258	139 0	1,397	19.0	9.3	9.9	5.4	990	73.2	83.5
G. E. R.	122,700	122,700	20 x28	59	180	29,044	1,632.6	201.6	1,834.2	26.5	7.8	10.9	4.2	1,048	69.2	66.8
M. R.	109,984	109,984	20 x26	63	160	22,490	1,170	313	1,483	21.1	8.4	21.1	4.8	1,210	70.7	74.0
H. & B.	114,672	114,672	19 x26	60	170	22,600	1,100	217	1,317	19.6	10.0	16.5	5.0	1,232	72.6	86.9
L. & Y.	99,120	99,120	20 x26	61	180	26,500	870	191	1,061	18.75	10.1	18.0	3.7	1,860	57.7	93.4
N. B.	122,500	122,500	19½x26	60	165	23,300	1,407.6	324.6	1,732.2	19.8	8.2	18.7	5.2	995	87.5	70.7
N. E. R.	96,300	96,300	18½x26	55¼	160	21,412	860	265.0	1,125.8	17.0	9.7	23.5	4.4	1,377	66.3	85.6
											9.0	16.9	4.6	1,103	70.5	80.0

Use of Factors in Designing

The factors which are proposed as being satisfactory for the purpose of making comparisons of different locomotives are also of use when considering the preliminary design of an engine for a given service.

Illustrating this by an example and specifying certain provisions as follows: Required the chief dimensions of an express 4-4-2 type locomotive to develop a tractive effort at the rim of the drivers at 60 m.p.h. of 7,500 lb.

$$\text{HP.} = \frac{T \times V}{375} = \frac{7{,}500 \times 60}{375} = 1{,}200 \text{ hp.}$$

Drivers are to be, say, 81 in. dia. At 60 miles per hour (240 r.p.m.) and with superheated steam, from 1.3 to 1.5 sq. ft. of evaporative heating surface will be sufficient (for saturated steam 2 sq. ft. or a little less would be wanted) to develop one hp. Assume 1.4 sq. ft. and factors as follows:

$$A = \frac{\text{Weight on drivers}}{\text{Rated tractive effort}} = 4.2$$

$$BD = \frac{\text{R.T.E.} \times D}{\text{Heating surface}} = 960$$

$$C = \frac{\text{Heating surface} + \text{superheating surface}}{\text{Grate area}} = 75$$

$$E = \frac{\text{Total weight}}{\text{Heating surface} + \text{superheating surface}} = 77 \text{ lb.}$$

Fire-box surface, 7 to 8 per cent of total.
Superheating surface, 20 per cent of total.
Total evaporative heating surface:

1,200 × 1.4 - - - - -	=	1,680 sq. ft.
Superheating surface - - -	=	420 sq. ft.
Total - - - - -	=	2,100 sq. ft.
Grate area - - - - - -	=	28 sq. ft.
Fire-box surface, 7.5 per cent of total	=	158 sq. ft.

$$\text{R.T.E.} = \frac{1{,}680 \times 960}{81} = 20{,}000 \text{ lb.}$$

Total weight = 162,000 lb.
Adhesive weight = 84,000 lb.

TABLE 8

Twelve Wheeled—4-6-2 Type Locomotives

Railway	Total weight	Adhesive weight	Cylinders dia.; and stroke, in.	Drivers dia. in.	Steam pressure	Rated tractive effort	Total heating surface evaporative	Superheater surface	Total heating surface	Grate area	Fire-box surface per cent of total	Superheater surface, per cent of total	Adhesive weight / Rated tract. effort	R.T.E. × D / Total heating surface evaporative	Total heating surface / Grate area	Total weight / Total heating surface
	Wt.	AW	d s	D	P	RTE	S	Sh	St	GA	FBS / St	SH / St	A	BD	C	E
						Pacific Type Tender Engine										
G. W. R.	214,910	134,400†	15 x26	80½	225	27,800	2,855.8	545	3,400.8	41.8	5.3	16.0	4.8	755	81.3	63.2
						Side Tank Engines										
G. C. R.	191,640	120,960	20 x26	67	160	21,600	1,431	214	1,649	21.0	8.7	13.0	5.6	1,010	78.5	....
L. N. W. R.	172,480	98,560	20 x26	68½	175	22,400	1,085.4	248.2	1,333	23.9	10.7	18.5	4.3	1,410	55.8	....
L. B. S. C.	198,100	122,000	21 x26	79½	170	20,800	1,585.8	357.0	1,942.8	25.16	6.4	18.3	5.8	1,043	17.4	....
C. R.	205,296	123,100	19½x26	69	170	19,486	1,516	200	1,716	21.5	7.0	11.6	6.2	887	79.7	....

†Four cylinders simple expansion.

TABLE 9

Twelve Wheeled—2-6-4 Type Locomotives

Railway	Total weight	Adhesive weight	Cylinders dia.; and stroke, in.	Drivers dia. in.	Steam pressure	Rated tractive effort	Total heating surface evaporative	Superheater surface	Total heating surface	Grate area	Fire-box surface per cent of total	Superheater surface, per cent of total	Adhesive weight / Rated tract. effort	R.T.E. × D / Total heating surface evaporative	Total heating surface / Grate area	Total weight / Total heating surface
						Side Tank Engines										
G. C. R.	212,800	134,400	21 x26	61	180	29,000	1,547	304	1,851	26.0	8.5	16.4	7.3	1,143	71.2	....
S. E. C. D. R.	184,900	118,200	19 x28	72	200	23,800	1,525.6	203	1,728.6	25.0	7.8	11.7	4.9	1,122	69.0	....
											8.1	14.0	6.1	1.132	70.1	....

TABLE 10

Fourteen Wheeled—4-6-4 Type Locomotives

Railway	Total weight	Adhesive weight	Cylinders dia.; and stroke, in.	Drivers dia. in.	Steam pressure	Rated tractive effort	Total heating surface evaporative	Superheater surface	Total heating surface	Grate area	Fire-box surface per cent of total	Superheater surface, per cent of total	Adhesive weight / Rated tract. effort	R.T.E. × D / Total heating surface evaporative	Total heating surface / Grate area	Total weight / Total heating surface
						Side Tank Engines										
L. B. S. C.	223,000	127,000	22 x28	80	170	24,200	1,687	383	2,070	26.6	7.3	18.5	5.2	1,146	77.6	....

The diameter and stroke of the cylinders will of course be easily arranged after the steam pressure of the boiler has been decided.

Equivalent Heating Surface

The equivalent heating surface, or in other words the amount of heating surface that an engine using saturated steam should have, would be by the usual formula

$$2{,}100 + \frac{420}{2} = 2{,}310 \text{ sq. ft.}$$

At 2 sq. ft. of heating surface per hp. this would furnish

$$\frac{2{,}310}{2} = 1{,}155 \text{ hp.}$$

This is less by some 3½ per cent, but is near enough to show that the formula, purely empirical as it may be, is near enough to give a fair idea of heating surfaces of superheated and saturated steam locomotives of the same horsepower.

Quite naturally the foregoing computations can be much upset if the power per unit of heating surface is greatly different, but the figures given will be found to be closely correct under average conditions, and for boilers having the average proportions adopted in estimating the size of the proposed 4-4-2 locomotive.

Conclusion

The tables of dimensions have been compiled from particulars given of the locomotives mentioned in various technical journals, principally The Engineer, Engineering, and The Railway Gazette, and some of the data has kindly been furnished by the locomotive engineers of the various railways.*

It will be understood that the examples might have been multiplied in number, but the aim has been to tabulate representative designs of modern power operating at the present time on British railways, and also to put forward a suggested means of comparing the various locomotives.

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*The writer is indebted to the chief mechanical engineers of the Great Central, Great Northern, North Eastern, North British, and South Eastern & Chatham Railways, who have kindly supplied information relative to their locomotives.

Recent Developments in the Storage of Coal*

There has been very little activity in connection with the storage of coal by railroads since the last report of the Storage Committee.

The Fairbanks-Morse Company report of the completion of three locomotive coaling stations, including yard storage of coal, built for the Erie. At Salamanca, New York, the coaling station consisted of four circular concrete bins of 1,000 tons capacity and tributary storage for 38,000 tons. A similar plant was built at Hornell, New York, with tributary ground storage for 33,000 tons. A 300-ton coaling station was also built for the Jacksonville Terminal Company at Jacksonville, Florida, where 300 tons is stored in overhead pockets and 2,500 tons on the ground.

All of these plants were of the drag scraper type which has been largely used by the Southern Railroad and has been described in previous reports of the committee. As to cost of operation of such plants, F. P. Drinker, manager, engineering department, Fairbanks-Morse Company, says that in 1914 observations of the operation of some of the plants on the Southern Railway showed that the cost of handling coal in and out of yard storage, including power and supplies and maintenance, averaged about 2½ cents each way, or 5 cents per ton, delivered to locomotives, and that this would indicate on the same basis a handling cost of from 10 cents to 12 cents per ton at the present time.

The Roberts & Schaefer Company report the development of a new type of storage in connection with the RandS portable coaling and cinder plant which is shown in the illustration. This type of coaling and storage plant may be equipped with a large capacity hoist or a small capacity hoist. A price for the structure complete above the rails and electrically operated, is quoted as follows:

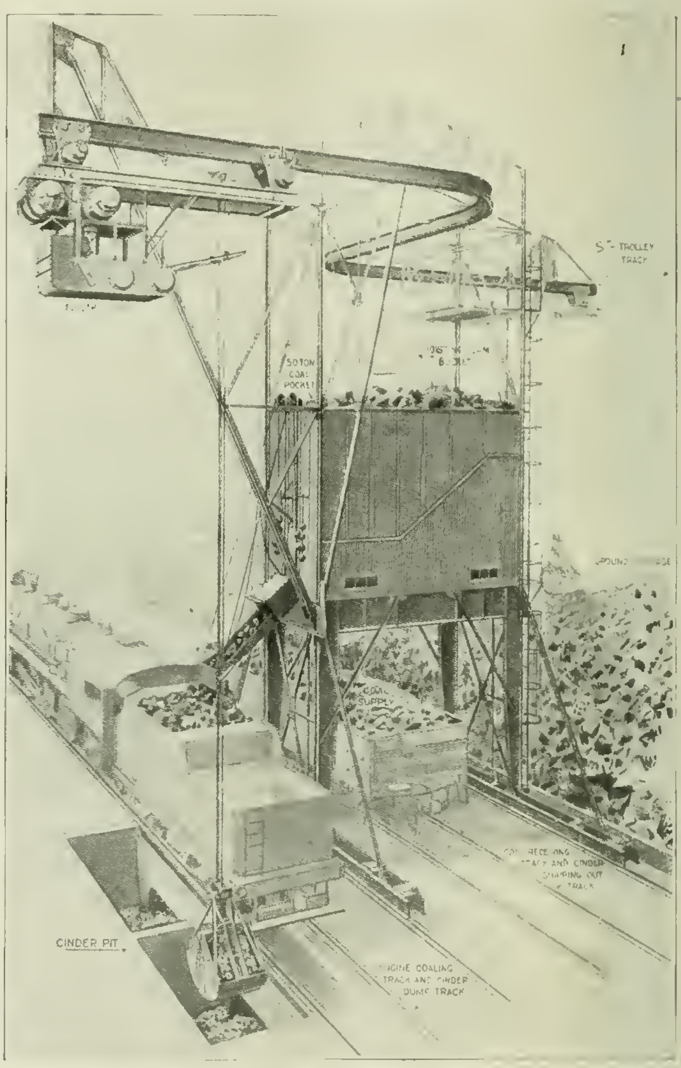
For large capacity hoist............................	$36,670
For small capacity hoist............................	34,490

No figures are available at this time for the cost of operation of the storage portion of this plant for it is difficult to obtain separate storage figures due to the fact that many of the railroads do not attempt to separate storage and coaling costs.

The Portable Machinery Company, Passaic, New Jersey, reports an installation of portable conveyors for the Atlantic Coast Electric Railway, Asbury Park, New Jersey. The pile contains about 3,000 tons and the Atlantic Coast Electric Railway reports that it can store 350 tons a day with four men unloading and attending the conveyors. The company reports that during the past two years it has built up a similar pile at four different times and later removed it to the station. At the other end of the power plant the company has a similar storage pile.

The Consumers' Fuel Company, Morgantown, W. Va., built in 1920 a Thornley storage plant. A number of inquiries in regard to storage of coal at the mines have been received, but a number of companies that have investigated the subject have concluded that such storage is not advisable unless an increased car rating may be obtained by the mining company as a result of such storage facilities. The general public and the large users of coal should have impressed upon them the fact that storage at the mine is not of any particular assistance to the railroads or to the consumers of coal in providing coal under emergency conditions, but acts merely as a safety valve upon operating conditions at the mine. The proper place to store coal to relieve the railroads and the consumer is as near as possible to the point of consumption.

The committee feels that one of the greatest problems is to get the higher railroad authorities to thoroughly understand the importance of the storage of coal and that they may appreciate the necessity for careful and systematic storage. Spasmodic attempts to store coal have always proven unsatisfactory both to the consumer and to the producer and that storage of coal may be successful it must be conducted regularly and in a methodical manner and by the fullest cooperation of producers, carriers and consumers. The storage proposition must be tied up with production to such an extent that it will co-ordinate properly, and when large stocks of coal have been stored the production and movement will have to be regulated in such a way that the storage coal can be used most advantageously and not become simply a high priced inventory article. The experience of the past three or four years shows conclusively that storage of coal must be more carefully considered and that only by such careful consideration can it become the stabilizing influence that it should.



Storage Plant in Connection With RandS Portable Coaling Station and Cinder Plant

If a practicable plan of storage at large distributing centers had been operating during 1919 it is probable that the November strike of that year would not have produced the condition of panic that followed during the spring and summer of 1920.

The report is signed by H. H. Stoek (University of Illinois), chairman; A. H. Davies, C. G. Hall (Walter Bledsoe & Co.); J. B. Hutchison (Texas Steel Co.); B. P. Phillippe (Penn System); R. E. Rightmire (Consolidation Coal Co.); A. P. Wells (Central of Georgia); H. Woods (Colorado & Southern); S. L. Yerkes (Grider Coal Sales Agency).

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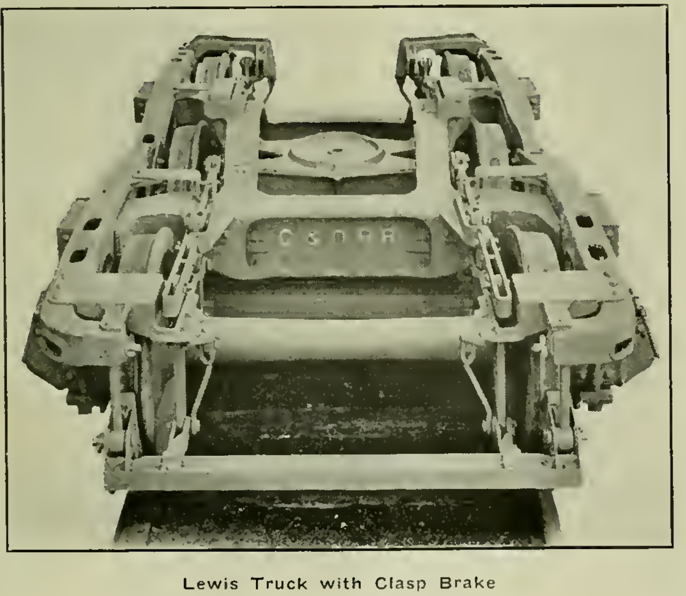
*From the 1921 report of the standing committee on storage coal of the International Railway Fuel Association

Chesapeake & Ohio Gondola Coal Car of 100 Tons Capacity

100-Ton Coal Cars for the Chesapeake & Ohio

High Capacity Cars Adopted for Handling Export Coal—Drop Doors Provided for Emergency Unloading

THE Chesapeake & Ohio handles a very large amount of export coal from the West Virginia and eastern Kentucky fields. The total tonnage which this road dumped at Newport News in 1920 was 7,264,000 tons, which was exceeded only by the Norfolk & Western. The pier is equipped with a pair of stationary turn-over car dumpers, each of which is capable of handling all sizes of cars up to those of 100 tons capacity at a rate of 30 cars an hour. The coal is dumped from the road cars into special transfer hopper cars which are lifted by an elevator, run along the pier and dumped into pockets. A large part of the export coal has been handled hitherto in hopper bottom cars of 70 tons capacity, but there has been considerable difficulty in preventing these cars from being loaded for interchange points.



Lewis Truck with Clasp Brake

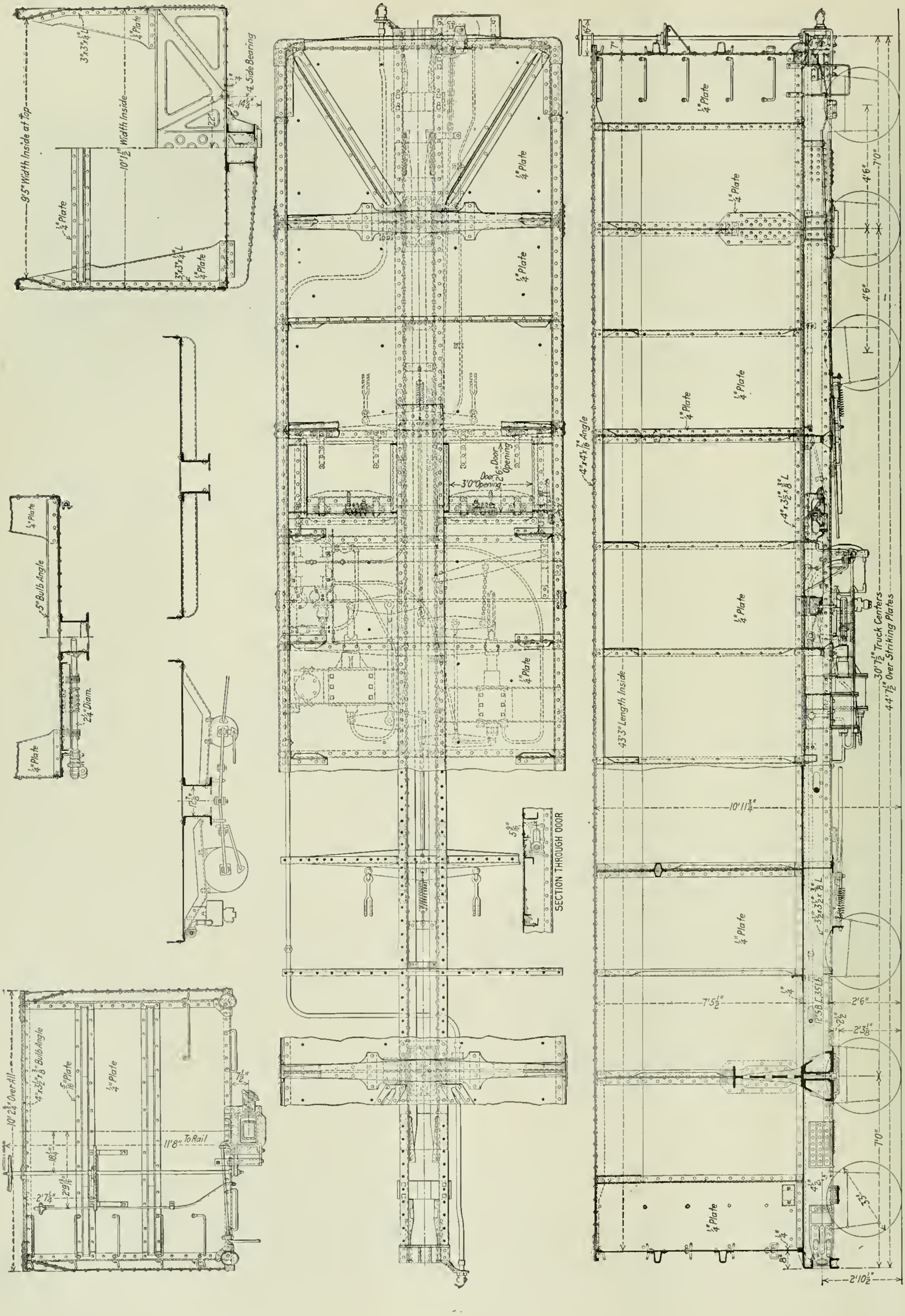
To facilitate the handling of tidewater traffic, the Chesapeake & Ohio last year ordered 1,000 cars of 100 tons capacity, of which 500 were built by the Pressed Steel Car Company and 500 by the Standard Steel Car Company. These cars are of the flat-bottom, high-side, gondola type and ordinarily will be unloaded by car dumpers. They are provided, however, with four drop doors which permit them to be unloaded in case of emergency at points where dumpers are not installed.

Of the three large roads which deliver coal to points on Hampton Roads, the Chesapeake & Ohio and the Norfolk & Western recently have adopted cars of 100 tons capacity, while the Virginian is using cars of 120 tons capacity. Both of these designs have been described in previous issues of the *Railway Age.*

Construction of the New Cars

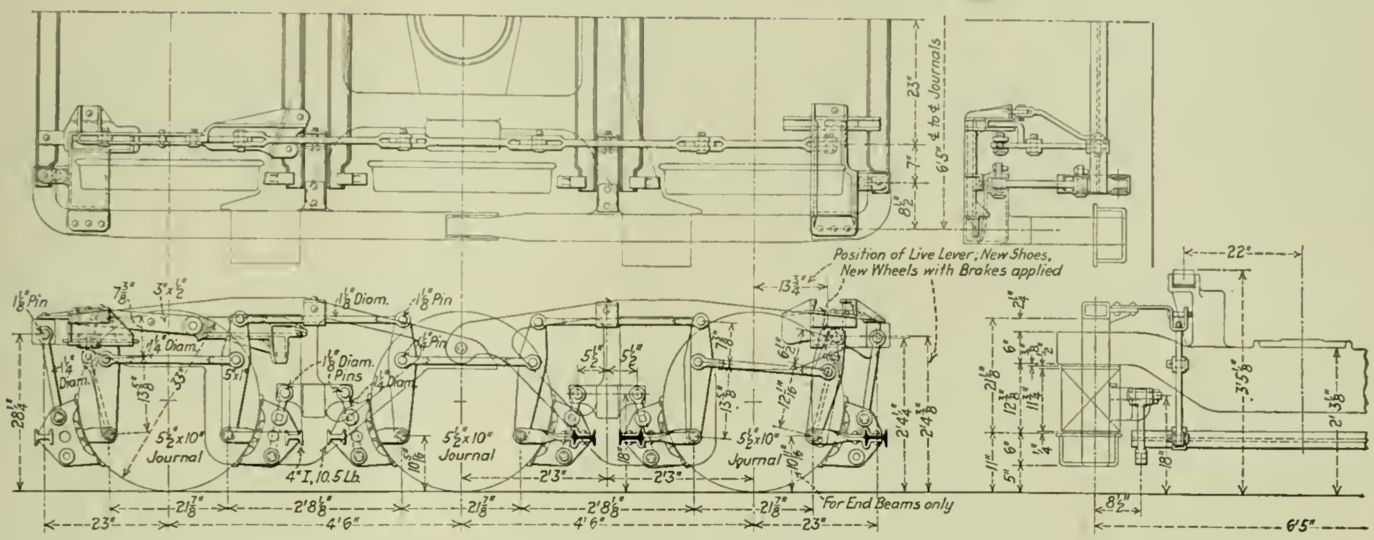
The inside dimensions of the new 100 ton capacity cars are 43 ft. 3 in. long, 10 ft. 1½ in. wide and 7 ft. 5½ in. deep. This gives a coal space of 3,212 cu. ft. when level full, or 3,703 cu. ft. when heaped at an angle of 30 deg. Using a factor of 54 lb. per cu. ft., the heaped load would weigh 200,000 lb. The cars, however, are stenciled as of 182,000 lb. capacity to provide for a 10 per cent overload. The length over striking castings is 44 ft. 7½ in.; the maximum outside width is 10 ft. 3⅝ in., and the height from top of rail to top of sides is 11 ft. The distance from center to center of the trucks is 30 ft. 7½ in. and the trucks, which are of the Lewis six-wheel type, have a wheelbase of 9 ft. The light weight of the car is 68,300 lb. and the weight on each axle with the car loaded is 44,717 lb.

The center sills are made up of two 12-in., 35-lb. channels with flanges facing out and reinforced at the bottom by 3½ in. by 3½ in. by ⅜-in. angles, extending between the draft gears, and at the top by the ¼-in. floor plates. There is



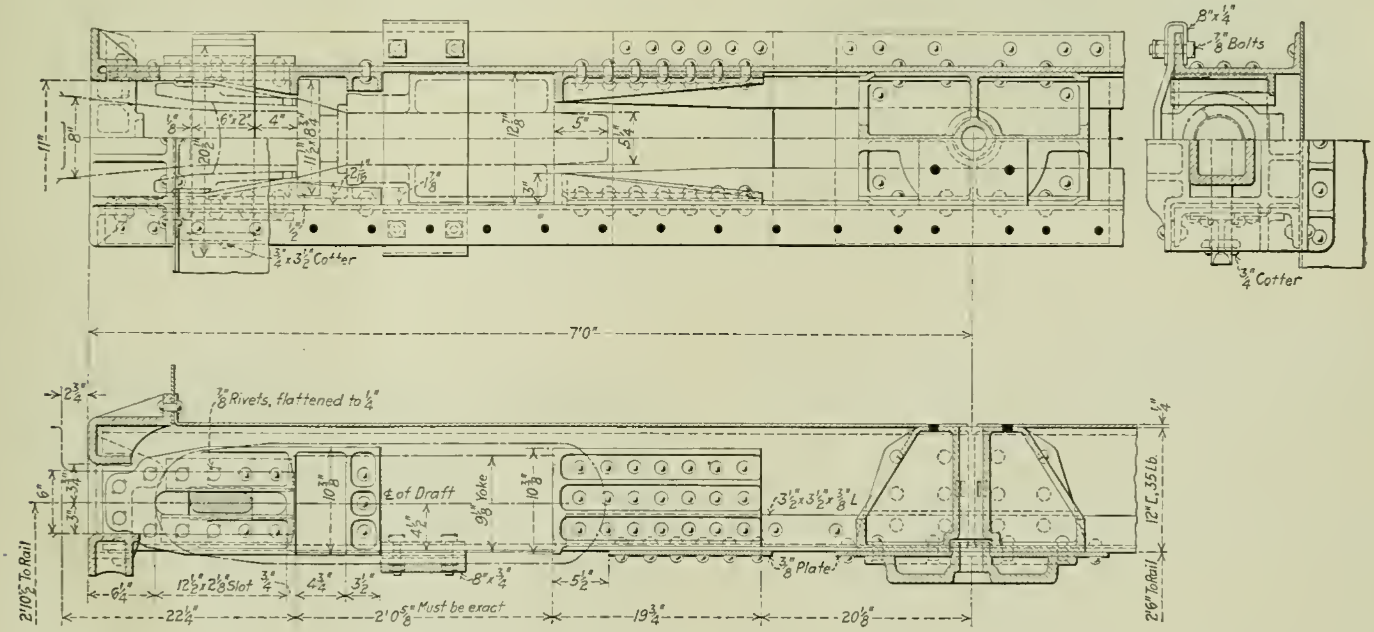
Plan, Side and End Elevations and Sections of Car Body—Chesapeake & Ohio 100-Ton Car also a reinforcement in the center of the car on top of the floor plates consisting of a ¼ in. plate 20 in. wide and extending slightly beyond the door openings.

The body bolsters are of cast steel. They are in one piece, 30 in. deep, located inside of the car body and reaching from side to side of the car on top of the floor. The body center plates are of cast steel, 16 in. in diameter, and have machined bearing surfaces. The body bolster center braces are of cast steel machined and the center brace brackets are also of cast steel. The body side bearings are open-hearth steel bars, 4 in. by ⅝ in. by 16 in., spaced 22 in. from the center of the car to the center of the side bearings, and with a clearance of ¼ in. between body and truck side bearings.



Clasp Brake for Lewis Six-Wheel Truck

The side sheets, placed outside the side stakes as in the Virginian 120-ton cars to give the maximum width inside the body, are of ¼ in. steel pressed in toward the top and reinforced by a 4 in. by 4 in. by 7/16 in. angle and at the bottom by a 4 in. by 3½ in. by ⅜ in. angle. Each side is also reinforced by nine ¼ in. pressed steel gusset side stakes located inside of the car. The sides are further stiffened on the outside at the top by four cast steel braces and by seven pressed steel braces, as will be noted from the illustration showing the side view of the car. The side sheets are set in at the ends to bring the grab irons inside of the outer face of the side sheets and are flanged over the end sheets. Reinforcing plates are provided at the ends of the body bolsters. The two sides are tied together by two crossbraces, one at each intermediate gusset brace. They are constructed of ¼ in. pressed plates, are of box shape and are shown clearly in the illustration of the inside of the car. Such braces were not used on the Norfolk & Western or on the Virginian cars, but should add materially to the stiffness of the sides.



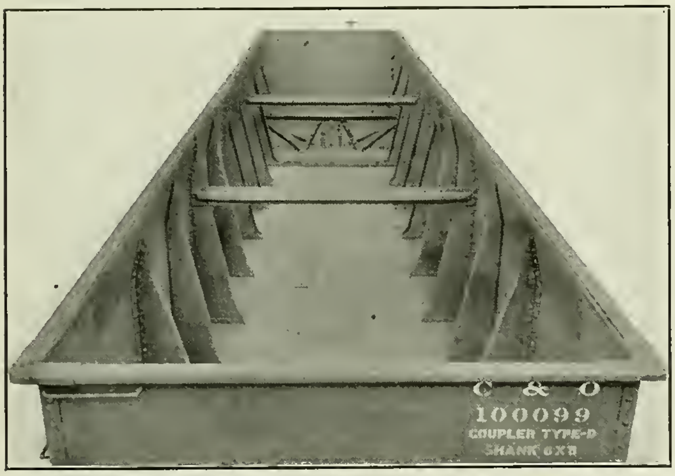
Draft Gear Arrangement

The ends are of ¼ in. steel sheets, reinforced at the top by a 4 in. by 3½ in. by ⅜ in. bulb angle and by two pressed steel U-shaped horizontal stiffeners of 5/16 in. steel, 5 in. deep at the center.

There are three cross-bearers, one at the center of the car and the others intermediate between the center and body bolsters, consisting of ¼ in. pressed steel diaphragms with 8 in. by ½ in. bottom tie plates, four crossties—two of pressed steel next to the center cross-bearers and two of 5 in., 9.3 lb. bulb angles on top of the floor next to the body bolsters—and a diagonal brace to each corner of ¼ in. pressed steel riveted to the top of the floor. The floor is made of ¼ in. open-hearth steel sheets.

The large capacity coal cars used on the Norfolk & Western and on the Virginian are not provided with bottom doors, it being assumed that they would always be emptied by car dumpers. The Chesapeake & Ohio cars have flush bottoms but are equipped with emergency drop doors which can be used when necessary to unload the car at a point where car dumpers are not available. The four drop doors, each with an opening of 2 ft. 6 in. by 3 ft., are located as shown on the drawings. They are operated in two sets. Part of the cars are equipped with door operating mechanism designed by the Pressed Steel Car Company and part from the design of the Standard Steel Car Company.

The trucks are of the Lewis, six-wheel type with cast steel side frames and bolsters designed and furnished by the American Steel Foundries. The wheelbase is 9 ft. and the journals are 5½ in. by 10 in., M.C.B. standard dimensions. The wheels are of wrought steel, part of them furnished by the Carnegie Steel Company and part by the Forged Steel Wheel Company. The side bearings consist of pockets cast integral with the truck bolster with cast steel filler blocks and three 3/16 in. shims in each pocket for adjusting the side bearing clearance to the nominal amount of ¼ in. The journal boxes are of pressed steel, Kensington type, manufactured by the Union Spring & Manufacturing Company.



Interior of Car Body, Showing Bolster, Gusset Side Stakes and Crossbraces

The cars are equipped with Westinghouse empty and load brakes, schedule KDE-4-10-16, having a 4-in. take-up cylinder, a 10-in. cylinder for use when the car is empty and an additional 16-in. cylinder for use when the car is loaded. The brakes are of the same type as those used on the Virginian as described in the *Railway Age* of June 17, 1921. Retaining valves are of the 10-20 lb. spring type.

The brake rigging is designed to give a braking effort of 40 per cent on the empty car and also 40 per cent on the loaded car. The trucks are equipped with clasp brakes having vertical levers. The brake beams are of 4-in., 10½-lb. I-beams with two sets of open-hearth forged steel brake beam fulcrums spaced on 3 ft. 10 in. centers and substantial malleable iron brake heads. The hand brake is of the geared and multiplying type. The wheel load is 5,692 lb. on the empty car and 22,358 lb. on the loaded car. The nominal brake shoe pressures are 2,277 lb. on the empty car and 8,943 lb. on the loaded car.

The draft gear is of the Miner A-18-S friction type with 2¾ in. clearance between the coupler horn and the striking castings. The cheek castings are of cast steel; each rear cheek has 27 ⅞-in. rivets; the front ones have 15 rivets. The draft sill tie is 8 in. by ¾ in. The couplers are A.R.A. type D with 6 in. by 8 in. shanks, connected by keys to cast steel yokes. The striking irons are of cast steel, the coupler carrier iron being cast integral with the striking casting.

In addition to the usual safety devices, the cars are provided with an inside ladder at each end.

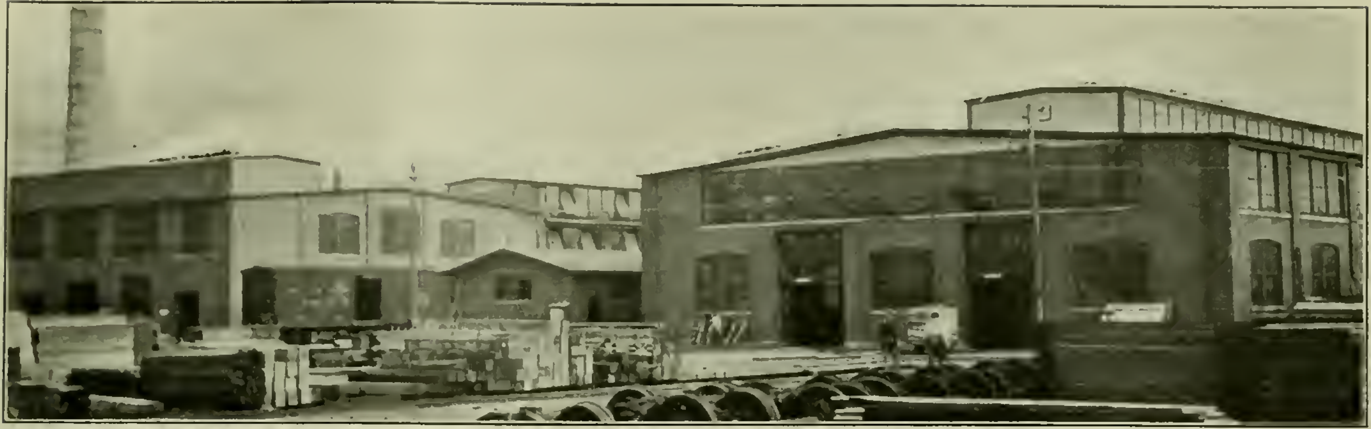
The accompanying table gives the principal dimensions and other data of these cars and in addition similar information in regard to the large capacity coal cars used on the Norfolk & Western and on the Virginian.

Railroad	Chesapeake & Ohio	Norfolk & Western	Virginian
Capacity, stencilled..	182,000 lb.	200,000 lb.	218,000 lb.
Capacity, heaped 30 degrees	200,000 lb.	200,000 lb.	240.000 lb.
Cubic capacity level..	3,212 cu. ft.	3,122.5 cu. ft.	3,850 cu. ft.
Cubic capacity, heaped 30 degrees.	3,703 cu. ft,	3,636 cu. ft.	4,450 cu. ft.
Estimated density of load	54 lb. per cu. ft.	55 lb. per cu. ft.	54 lb. per cu. ft.
Length over striking plates	44 ft. 7½ in.	43 ft. 9 in.	50 ft. 8¾ in.
Coupled length......	47 ft. 1 in.	46 ft. 2 in.	53 ft. 3½ in.
Truck centers.......	30 ft. 7½ in.	31 ft. 8 in.	36 ft. 10¾ in.
Truck wheelbase....	9 ft. 0 in.	8 ft. 6 in.	8 ft. 8 in.
Height, rail to top of car side.......	11 ft. 0 in.	11 ft. 0 in.	11 ft. 0 in.
Length, inside	43 ft. 3 in.	42 ft. 7 in.	49 ft. 6 in.
Width, inside.......	10 ft. 1½ in.	9 ft. 6 in.	10 ft. 2¾ in.
Depth, inside, center.	7 ft. 5½ in.	8 ft. 6¼ in.	8 ft. 5⅛ in.
Depth inside, ends..	7 ft. 5½ in.	7 ft. 5¾ in.	7 ft. 4¼ in.
Width outside, extreme	10 ft. 3⅝ in.	10 ft. 1¼ in.	10 ft. 3¼ in.
Weight of car body.	34,900 lb.	29,020 lb.	43,200 lb.
Weight of two trucks	33,400 lb.	24,480 lb.	35,700 lb.
Weight of empty car.	68,300 lb.	53.500 lb.	78,900 lb.
Weight loaded......	268,300 lb.	253,500 lb.	318,900 lb.
Per cent revenue load of total weight...	74.6 per cent	78.9 per cent	75.3 per cent
Rail load per axle, loaded car........	44,717 lb.	42,250 lb.	53,100 lb.
Weight loaded per foot coupled length	5.695 lb.	5,490 lb.	5,985 lb.

Admirers of Henry Ford who believe that he can convert any weak railroad into a strong one seem at least to have the virtue of sincerity; a party of them have journeyed all the way from Arkansas to Michigan to see if they can get him to revive the Missouri & North Arkansas, a 300-mile road which numerous experts have found beyond their powers. The "committee," said to represent several towns, had to deal with Mr. Ford's secretary, the "wizard" himself being absent.

* * * *


Austrian Munitions Factory Converted to Locomotive Shop



The Railroad Shop vs. the Contract Shop

Analysis and Comparison of Costs of Repairing 50 Similar Cars in Railway and in Contract Shops

THE relative cost of making heavy repairs to equipment in railroad shops and in outside contract shops has long been a matter of speculation. This subject has been discussed many times in the past and is a particularly live issue at the present moment. Much confusion has existed in making comparisons, due to the radically different cost accounting methods used in railroad and in contract shops. In order that comparisons may be of any real value similar things must be compared. As long as a common basis of measure is not used, attempts at comparisons must be always more or less futile. Unfortunately, railroad and industrial costs are not computed on a common basis. Railroad accounting methods are very effective in disguising many factors entering into cost accounting and, therefore, cannot be used for comparison with outside costs until certain additional elements are computed.

In a series of articles by J. W. Roberts, president of the Roberts-Pettijohn-Wood Corporation, Chicago, published in the Railway Age, an analysis and comparison is made between the cost of repairing 50 freight cars in the shops of one of the large trunk lines and similar repairs in a contract shop. This comparison brings out many important points frequently overlooked.

Railroad Accounting Methods

The accounting system used on railroads is prescribed by the Interstate Commerce Commission. Unfortunately this system resembles in no way cost accounting as practiced by industrial manufacturing plants or by other public utilities. The first cost found in railroading is considered the ultimate cost and many additional factors, known in commercial accounting as overhead, are not included. Railroad accounts are designed to furnish the cost of providing transportation and only incidentally the cost of maintaining equipment.

General accounts cover such main divisions as Maintenance of Way and Structures; Maintenance of Equipment; Traffic; Transportation—Rail; etc., but the demarcation between the Maintenance of Way and Structures and the Maintenance of Equipment accounts are in many places indistinct; likewise between these two general accounts and the Transportation—Rail, account. For example, the expense incident to hauling materials for use in maintaining the roadway and structures and for repairing and rebuilding equipment, etc., is not distributed between departments, but is charged to the Transportation—Rail, account; the maintenance of shops and enginehouses even though the former are used in the maintenance of equipment, is charged to the account maintenance of way and structures; the expense of maintaining pile drivers, steam shovels and similar devices used in roadway maintenance is classified as maintenance of equipment. As another illustration, the expense entailed in hauling fuel used at shop power houses is not charged as a shop operating expense. Depreciation of buildings and tools is not fully accounted for. The overhead, being a general expense, is considered as common to all the activities of the railroad and is not separated for the different departments, such as the transportation department or the car department.

Investment in railroad shops, shop equipment, power plants, storehouses and service tracks is an appreciable one and frequently is subject to rapid deterioration. The cost of losses on these investments and the cost of providing money for improvements and taxes are all items properly chargeable against the railroad shop output, but are most difficult of ascertainment. Even the direct money outlay made in establishing railroad shop facilities is seldom known. In the case of a railroad, the expenses incurred in repairing cars in its own shops, other than the direct charges for productive labor and applied materials are usually so confused and so difficult of ascertainment that they are not recognized or are ignored. The repair of equipment being only an incidental affair in the operation of a large railroad system, there is an opportunity for other activities to carry and absorb many expenses which must be considered in commercial shop accounting.

A commercial shop is obliged to consider not only direct outlay for productive labor and applied materials, but likewise every other item of expense, however indirectly or remotely it may be involved. It must provide for expenses due to casualties or such other contingencies as sub-normal production. Provision must be made for taxes and a reasonable return from investments in fixed assets and working capital. Unlike a railroad, it usually has but one general source of revenue and a single outlet of expense and its selling price must provide for profits upon its raw material and their delivery. The necessity for careful management and economical performance is manifest as these affect the prices which must be charged for service. The cost to a railroad of having work done in outside shops consists of a known outside shop cost to which must be added the expense to the carrier incidental to having the work done outside. The outside shop costs under normal conditions will include direct charges for labor and material and sufficient overhead for the use of property, working capital, enlargements, a margin for contingencies and what is commonly called profit.

Comparison of Railroad and Contract Shop Costs

A large railroad with excellent shop facilities having occasion to repair a large number of 60,000 lb. capacity wooden box cars, decided to overhaul part of them in its own shops and at the same time let a contract to a prominent car company, whose plant was situated on the carrier's line, for repairing a portion of the cars. This decision afforded an unusual opportunity for obtaining comparative costs.

The cars referred to were practically rebuilt. They received from three to six new sills; one or both new side plates and end plates; practically all new siding, decking, lining and roof sheathing, new doors, corner and end posts, Z-bar or Economy ends; "XLA" or Murphy roofs; Economy draft arms; two new side doors equipped with National door fixtures; Cardwell friction draft gear; heavier oak subsills; heavier needle beams, heavier U. S. Standard safety appliances and two coats of paint. The trucks were overhauled; wheels, springs and truck castings being renewed as found necessary; braces were placed on the arch bars to strengthen the truck in general and all brake attachments were repaired or renewed as required. When the work was completed, the rebuilt cars were practically as good as new cars of the same construction.

The railroad in question was above the average in physical condition of shops and equipment. The shops had been established only about five years and the equipment was comparatively new. The shop in question was devoted exclusively to heavy repairs and had been working for several months on similar repairs to the same line of cars.

For the sake of comparison, 50 cars were selected at the railroad shop and 50 cars in practically the same condition were selected at the contract shop. Unusual precautions were taken to obtain accurate costs for the two lots of cars. The accounting was done by outside men with the active co-operation and assistance of the railroad's officers.

Computing Total Cost of Work in Railroad Shop

The carrier does not accumulate in its record the cost pertaining to individual repair jobs, and it was therefore necessary to examine the details and build up the cost from the beginning. An enumeration of the various elements entering into the cost computation will show the method pursued and will also be suggestive in connection with similar work which may be done in the future at other points. In computing costs, the 50 cars were considered as a unit. The results given in this article, however, are for one car and were obtained by dividing each total item by 50.

Applied Material

A record was kept of the character of repairs made to the cars and the quantity of applied material was carefully developed in detail. Material reported used was checked against the work record and from the latter record a list of minor items not reported, which of necessity were used in the repairs, was compiled in conjunction with the local officers and car foreman. The different items were totaled and priced out from the storekeepers' and purchasing department records at prices f.o.b. carrier's rails at points of delivery.

Haulage Over Carrier's Line

The net weight of each item was computed, the distance hauled over carrier's line from point of delivery thereto to the shop where applied was ascertained and the net ton miles figured, and the cost of haulage calculated at the rate of seven mills per net ton miles.

Losses resulting from material spoiled in fabrication have been omitted; likewise losses due to shortages in shipments, breakages in handling and like causes were not included. Neither was anything included for inventory adjustments.

Salvaged Material and Scrap

Credit was given for recovered material salvaged from the repaired cars at the rate of 75 per cent of the current cost of new usable material and at current prices for scrap. The cost of handling is not deducted in this connection as the expense was included in overhead accounts and distributed as such.

Direct Labor

Carpenter labor was taken directly from the service records. Record cards were turned in by the workmen which showed the individual car worked on each day and the time devoted to each operation on each car. The total time reported was checked against the payrolls. Service cards were not required of the other classes of men, however, and it was necessary to use an average cost per car for these respective classes of labor. Certain work, such as riveting coupler yokes, rectifying body bolsters, and reclamation shop recovering 16 journal boxes and four-column bolts, was done in other departments which did not record the time devoted thereto. The cost of these items was determined from a performance time study and the application of the standard rate of pay.

Indirect Shop Labor

Indirect labor in each department each month has been apportioned on a basis of the departmental direct labor. For instance, mill foremen and mill men have been distributed on the basis of carpenter labor, and assistant general foremen, clerks and watchmen on the total labor to which each expense was common.

Shop Expense

The total shop expense for labor, operating materials and supplies, fuel, electric current consumed and ice was found for four months during which the work was under way. This was then pro-rated against the test cars. These charges include nothing for haulage of the fuel used over the rails of the company. The tonnage of fuel used was ascertained, likewise the distance hauled over the carrier's line from the normal sources of supply, and haulage costs were computed at the rate of seven miles per net ton mile. The cost of transporting material and supplies is necessarily omitted because of inaccessibility of the data as to weight and point of origin. Shop expense was apportioned on the basis of assigned shop labor.

Insurance

Premiums paid on commercial policies for fire insurance and allowances on the carrier's own insurance fund to protect the margin between the insurance carried and the amount of hazard on the insured facilities comprising the shop layout, was reduced to a monthly basis and distributed on the basis of assigned shop labor.

Maintenance of Machinery and Tools

The total expense charged to accounts 302—Shop Machinery, 304—Power House Machinery, and 335—Other Expenses, representing the total expenditures during the test period at the shop in question, was apportioned on the basis of assigned shop labor. The records did not lend themselves to analysis in such a way as to permit of averaging the machinery maintenance expense for a longer period which apparently would have increased the charges somewhat.

Maintenance of Buildings and Track

The labor and material charged during the year 1920 against the maintenance of the buildings and track comprising the shop facilities was taken as the basis for ascertaining the cost of maintenance of these facilities. The total charges were reduced to a four months' average and this amount apportioned on the basis of assigned shop labor. In the charges thus distributed, nothing was included for transporting the materials used over the carrier's line, which could not be computed because of lack of detail as to material quantities. The records were not kept in such detail as to show the facilities to which repairs were made and repair expenses not described may have applied to the facilities in question. Cognizance was taken only of the charges identified to the facilities involved.

Maintenance of Buildings Used in Common

Other shops than the one in which the test cars were repaired are located at the same point and during the year 1920 account 235—Shops and Enginehouses received charges common to all such shops. Charges for the period were reduced to a four months' average and then distributed on the basis of assigned shop labor (less superintendence) in all shops.

Divisional Overhead, Maintenance of Way and Structures

Divisional charges, accounts 269—Roadway Machines, 271—Small Tools and Supplies, 274—Injuries to Persons, 276—Stationery and Printing, 277—Other Expenses, exclusive of accounts benefited thereby as, for instance, account 275—Insurance, were apportioned in a similar manner.

Entire Line Overhead, Maintenance of Equipment

Superintendence and other overhead expenses, accounts 201—Superintendence, 332—Injuries to Persons, 334—Stationery and Printing, were ascertained and their relationship between total overhead expense and the total expense supervised was found and on the basis of this relationship the supervised expenses were assigned against the test cars.

It should be mentioned that divisional overhead expense relating to maintenance of equipment was consolidated with system charges by the carrier and could not be segregated and separately accounted for. The consolidation of the expense before apportioned reduces the proportion which would otherwise be assignable to the work in question.

Entire Line Overhead, Maintenance of Way and Structures

The charge against the test cars for system overhead applicable to all maintenance of way and structures accounts, which is represented by charges to account 201—Superintendence, was predicated upon the equitable distribution of the total charges to this account on the basis of the total expenses supervised, using the experience of the calendar year 1920.

Entire Line Overhead, Repairs to Offices and Storehouses

The identifiable expenditures for repairs to system general offices and general storehouse buildings and appurtenances during the year 1920 were collected and their relation to total operating expenses (less common to system repairs) and expenditures for additions and betterments were found and on the basis of this relationship, the cost assigned to the test cars was surcharged pro rata.

System General Expenses

System general expenses for the year 1920, comprising items included in the various primary accounts under the subdivision "General" were found to be equivalent to 3.473 per cent of the total expenditures for other operating expenses plus the expenditure for additions and betterments to road and equipment, excluding the adjusting credit of the property retired and the amount of liability for certain equipment allocated by a government order which involved no general expense during this period on the part of the carrier's organization.

Depreciation on Shop Buildings, Tools and Machinery

The railroad's policy does not provide for a maintenance fund for perpetuating the life of such property, although deterioration not offset by current repairs does accrue. Depreciation was therefore computed upon buildings and depreciable machinery used in the repair of cars on the basis of the original cost for each item. Cognizance was taken of the character of each item and depreciation was based upon experience as to the life expected of such property. The rates used were taken from a table promulgated by the U.S.R.A. for the use of car builders computing the cost of work performed on a cost plus contract and which was subsequently adopted for use by many builders.

It was impossible to ascertain the amount of taxes and other fixed charges which should be borne by the property and equipment devoted to car repairs. During the year 1920, for each one dollar distributed as operating expenses as designated by the Interstate Commerce Commission's classification, the carrier had a further outgo for fixed charges which include taxes, uncollected revenues, operating losses, etc., of 20.081 cents. Because of the lack of a more equitable basis for disposing of this element of cost, it was assigned to the test cars on a pro rata basis. This may not be strictly accurate, but it has nevertheless done substantial justice to the situation in arriving at a comparable cost.

Basis of the Contract for Outside Repairs

Under the terms of the contract, the work done in the outside shop was to be charged for on the following basis:

(a) Direct labor to be based on the carrier's piece work schedules which were in effect July 1, 1917, plus 10 per cent, plus 30 per cent (the equivalent of 43 per cent) to equate such rates to the basis of the current wage schedule.

(b) For handling materials, a charge of $6 per car.

(c) For milling lumber, a charge of $8 per thousand board feet.

(d) For blacksmith work, agreed prices per operation.

(e) The aggregate of the foregoing items to be surcharged 100 per cent for overhead expense.

(f) Materials to be furnished in part by the carrier and to that extent exempted from the surcharge for profit; in part to be furnished at reciprocal prices (i. e., furnished by the carrier and billed at agreed prices and rebilled by the contractor at the same prices) and subject to the surcharge for profit, and in part to be furnished by the contractor at agreed prices, subject to the surcharge for profit.

(g) To the sum of the foregoing items to which applicable, profit to be added on a graduated scale, regulated by the amount of charge per car, the average rate of profit surcharged being between 10 per cent and 11 per cent.

The amounts billed the carrier under the terms of the contract do not, of course, represent the sole cost to it of the work done by the contractor. Among the possible incidental expenses may be mentioned:

(a) The cost to it of free materials furnished the contractor, and not included in his bill.

(b) The cost of delivering such materials, and attendant store expenses, etc.

(c) Moving the cars to be repaired to the contract shop, and returning them, to the extent that such movement represent otherwise useless haulage.

(d) Concentrating recovered scrap.

(e) Inspection of work, and reviewing accounts at the contract shop.

(f) Unoccupied space in its own shops and attendant expense, idle investment, etc.

(g) Administrative, purchasing and accounting expense.

These, and other kindred items have received careful attention, and to the extent that such expenses were experienced, have been added to the amounts billed by the contractor in arriving at the total cost of the outside shop work.

Compiling Cost of Work in Contract Shop

APPLIED MATERIAL

This includes all material supplied by the builder for which bills were rendered and also certain so-called "free" material furnished by the railroad to the contractor, and delivered at the contractor's works. This material consisted of car roofs, draft arms, door fixtures, draft gear, and steel car ends, the value of which was ascertained from the purchase records. The cost of hauling the material over the carrier's own line and delivery at the car plant was computed at seven mills per net ton mile. Aside from the small amount of material furnished from the general storehouse to accommodate immediate needs, this material was moved direct in car load lots and was not subject to storehouse accounting. The cost of purchasing and accounting for it is included in general expense apportioned to the contract cars, the same as company repaired cars.

CREDIT FOR SALVAGED MATERIAL AND SCRAP

The contract covered the basis on which scrap and useful material recovered would be accounted for. Recovered material, valued at 75 per cent of the cost new, amounted to $81.30 per car. In addition there was recovered an average of 892 lb. of miscellaneous scrap per car at $15 per ton, or $6.69 per car. From the total salvage per car is deductible the cost of handling as charged under the contract, plus 10 per cent for profit, or $2.20 per car. The net weight of the usable material and scrap was used as a basis for computing the cost of hauling by the carrier at seven mills per net ton mile from the contract plant to the usual point of scrap concentration. The cost of unloading the concentrated scrap and useful material is included in the carrier's storehouse expense in which the materials handled for both shops have been caused to participate on an equitable basis.

DIRECT LABOR

All direct labor, including that for handling materials, milling lumber and blacksmith work, was billed as per contract.

OVERHEAD EXPENSES

This includes the contractor's overhead at 100 per cent of the direct labor provided for in the contract and also a contractor's profit as provided for in the contract.

Additional incidental expenses borne by the carrier include switching cars to and from the plant of the contractor equivalent to seven dollars per car. To this is added an item covering the system general expense as it is considered that the railroad's general expenses representing administrative and supervisory expenses, purchasing, accounting and similar items of a general character, are applicable to the cost attached to the outside contract.

The cars repaired at the contract shop, which is located at an intermediate point on the carrier's system, were not given any special movement to make them applicable for repairs. The cars were selected from those moving through or made empty at the terminal at which the repair plant is located. The only expense involved was the switching to and from the plant. The same practice was followed at the railroad's shop. In both cases, also, the points being tonnage producing stations, as cars were repaired and released they were simply contributed to the local supply ready for loading and special movements to loading points were unnecessary.

The carriers provided car inspectors and accountants at the contract shop to pass on the quality of work and to verify the charges of the contractor. The cost of this inspection and accounting was found to be approximately $16.00 per car. This expense, however, was charged to the overhead account from which a pro rata share was charged to the test car. For this reason the charge of $16.00 per car was not included in the cost.

FIXED CHARGES

It has been previously shown that the ratio of fixed charges to the carrier's expenditure for operating expenses, additions and betterments, for the year 1920 was 20.081 cents per dollar of expenditure. As the letting of certain work to outside shops did not result in idle investment it is not clear to what extent, if any, the cost dependent upon the contract work should be increased because of interest, taxes, operating losses, etc., which are incident to the carrier's operation. It might not be fair to say that no portion of this amount should be included as a part of the cost in question, but it is quite obvious that under the circumstances it would be unfair to say that the entire amount should be considered as a part of such cost. If this were done, the comparison would be on the basis substantially that the railroad shops were in disuse. It seems best, therefore, to leave this question to the judgment of the reader.

Summary and Comparisons

It is most difficult, as has already been stated, to obtain a true comparison in an instance of this kind. However, the summaries given in Table 1 and Table 2 are as complete and fair as possible to both shops.

TABLE 1—ANALYSIS OF THE COST OF WORK IN RAILROAD SHOPS

Applied materials:	
Applied materials, prime cost	$903.18
Haulage over carrier's line	29.63
Less net value salvaged material and scrap	—87.99
Net cost of material	844.81
Direct labor:	
Carpenters	$232.72
Steel workers	8.52
Blacksmiths	7.30
Air brake men	5.60
Painters	4.80
Door makers	2.80
Mounting car wheels	1.62
Miscellaneous	3.71
Total cost of direct labor	$267.07
Overhead expenses:	
Indirect shop labor	$87.91
Shop expense (labor, material, power, etc.)	47.67
Insurance on buildings and machinery	0.26
Maintenance of machinery and tools, direct charge	26.34
Maintenance of buildings and tracks, direct charge	4.72
Maintenance of buildings used in common	1.16
Divisional overhead maintenance of way and structures	0.13
Line overhead maintenance of equipment	34.40
Line overhead maintenance of way and structures	0.30
Line overhead repairs, offices and storehouses	0.05
System general expenses	48.72
Depreciation on shop buildings, tools and machinery	6.65
Total operating overhead	$258.31
Total cost exclusive of fixed charges	$1,370.19
Fixed charges for interest, taxes, etc	292.82
Total average cost per car	1,663.01

TABLE 2—ANALYSIS OF THE COST OF CONTRACT WORK

Applied materials:	
Applied materials, billed	$544.39
"Free" materials at cost to carrier	360.34
Haulage over carrier's line	7.74
Less net value salvaged material and scrap	—83.21
Net cost of material	$829.26
Direct labor:	
Labor on equated piecework base, billed	$131.81
Handling materials, billed	6.00
Milling lumber, billed	15.35
Blacksmith work, billed	8.56
Total cost of direct labor, billed	$161.72
Overhead expenses:	
Contractor's overhead, billed	$161.72
Contractor's profit, billed	89.88
Cost of switching	7.00
System general expense	46.29
Total overhead and profit	$304.89
Total cost to carrier, exclusive of its fixed charges	$1,295.87
Apportionment of fixed charges on same basis as applied to carrier's cost of work done in its own shops	276.93
Total cost to carrier if above fixed charges were included	$1,572.80

In connection with the analysis of the cost of the work in the railroad shop, attention should be drawn to the fact that of the costs pertaining to the work done, only direct labor, shop expense and applied material costs to the extent of $1,297.47 were identified in connection with the carrier's accounts. The remainder, $365.54 was charged to other accounts or not included at all. In other words, of the total costs to the carrier as developed, 78 per cent could be identified and recognized if the accounts were analyzed, while 22 per cent was either omitted from the accounts entirely or so disguised as to appear unrelated to the expense of repairing cars.

Division of Total Cost of Outside Work

	Paid to contractor	Additional railroad costs
Applied materials, etc.	$544.39	$368.08
Less salvage credit	......	—83.21
Direct labor	161.72	.....
Overhead	161.72	53.29
Profit	89.88	.....
Total, exclusive of fixed charges	$957.71	$338.16
Fixed charges, if included	......	276.93

An examination of the analysis of the cost of the contract work shows that only part of the expense was an actual payment under the contract, the balance being for material and overhead borne by the railroad and not covered by any direct bills. The accompanying summary shows the division of costs.

A comparison of the analysis tables for the two shops shows a comparatively small difference in the costs of materials and a considerable difference in the item for labor. There is an apparently higher allowance for overhead in the contract shop, but no conclusions can be drawn as the methods used for arriving at the overhead were radically different in the two shops. As has already been pointed out, the inclusion of a sum for fixed charges in connection with the work done at the contract shop is debatable.

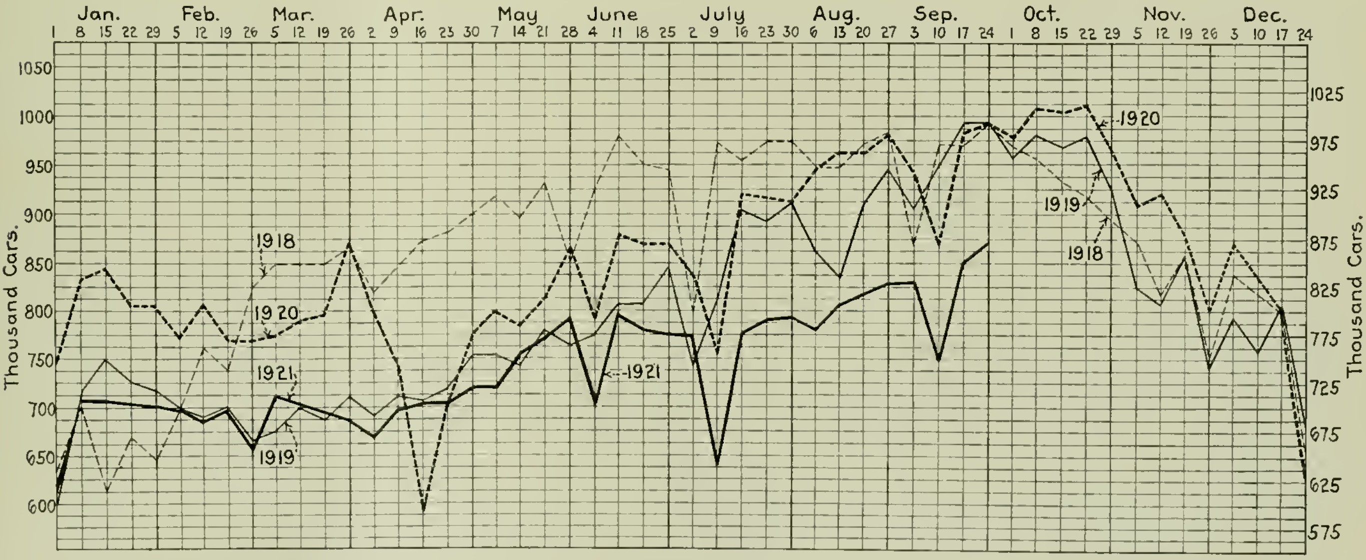
If fixed charges are not added to the cost of the contract work, the average cost per car is $1,295.87 against $1,663.01 in the railroad shop, a saving of $437.14 or 22 per cent of the railroad shop cost. If the full fixed charges are added to the cost of the contract work, it becomes $1,572.80, or $90.11 less than the cost in the railroad shop, which represents a saving of about 5½ per cent.

Bad Order Cars Reached Maximum in August

Analysis of Present Situation and Its Bearing on the Problem of Freight Car Repairs

THE first decrease in the number of bad order cars that has occurred this year took place in the last half of August. The reduction was slight, from 16.6 to 16.2 per cent, but it is significant as indicating that the railroads have at last begun to repair cars faster than they are made bad order. A survey of the present situation will show how great a task it will be to get the number of bad orders down to a normal figure.

On January 1, 1921, there were 191,234 bad order cars reported which amounted to 8.5 per cent of the total number of freight cars on line. This is over twice the normal percentage and ordinarily would have resulted in an intensive campaign to improve car conditions. At that time, however, the roads were in a very serious financial condition. In fact, during the months of January and February, most of them operated at a loss, so it was not possible to increase expenditures for car maintenance. Later the roads were looking forward to a reduction in wages and so were led to postpone repair work still longer. On July 1, when the new wage rates became effective, the unserviceable cars amounted to 354,611, or 15.4 per cent. Even though many shops were reopened on July 1, little progress was made in stopping the increase of bad orders which rose to 382,440, or 16.6 per cent on August 15.



Fluctuation in Freight Traffic from 1918 to Date, as Shown by Weekly Revenue Car Loading

As already noted, the number of cars in need of repairs was brought down on September 1. The figures for September 15, however, show that during the next two weeks the bad orders remained practically stationary.

Freight Traffic 76 Per Cent of 1920

The railroads would be unable to operate with such a large number of bad order cars if business was normal. If traffic should increase rapidly, the large amount of unserviceable equipment would prove a serious handicap. Business during the early part of the year has been far below normal but the number of freight cars loaded weekly is now increasing at a fairly steady rate as is evident from the chart showing the revenue car loadings for the past four years. Comparison of the loadings for 1921 with previous years is confusing because of the abnormal conditions which have influenced loading in the period included on the chart. The early months of 1919 represented a rather severe depression while the latter part of 1919 and the first 10 months of 1920 was the busiest period the railroads have ever experienced. It is evident that a steady improvement is taking place in the car loadings, but the increase is little more than has occurred in previous years and seems to be due largely to the seasonal fluctuation in the amounts of traffic to be handled, rather than to any distinct improvement in business.

Car loadings are a rather unsatisfactory basis for comparison of traffic because of the variations in the amounts loaded in each car. For instance in the first seven months of 1920 the average net tons per loaded car was 28.6, but during the first seven months of 1921 it fell to 27.9. The ton mile movement is a more satisfactory basis of comparison, but unfortunately these figures are not available as promptly as the reports of car loadings. The ton miles of freight moved in the first seven months of the present year was 76.5 per cent of that moved in the corresponding period of 1920, while the car loadings were 89 per cent of the 1920 figure. The last figure for the weekly car loadings available for this year is 89 per cent of the corresponding week in 1920, which is no higher than the ratio that has existed throughout the year.

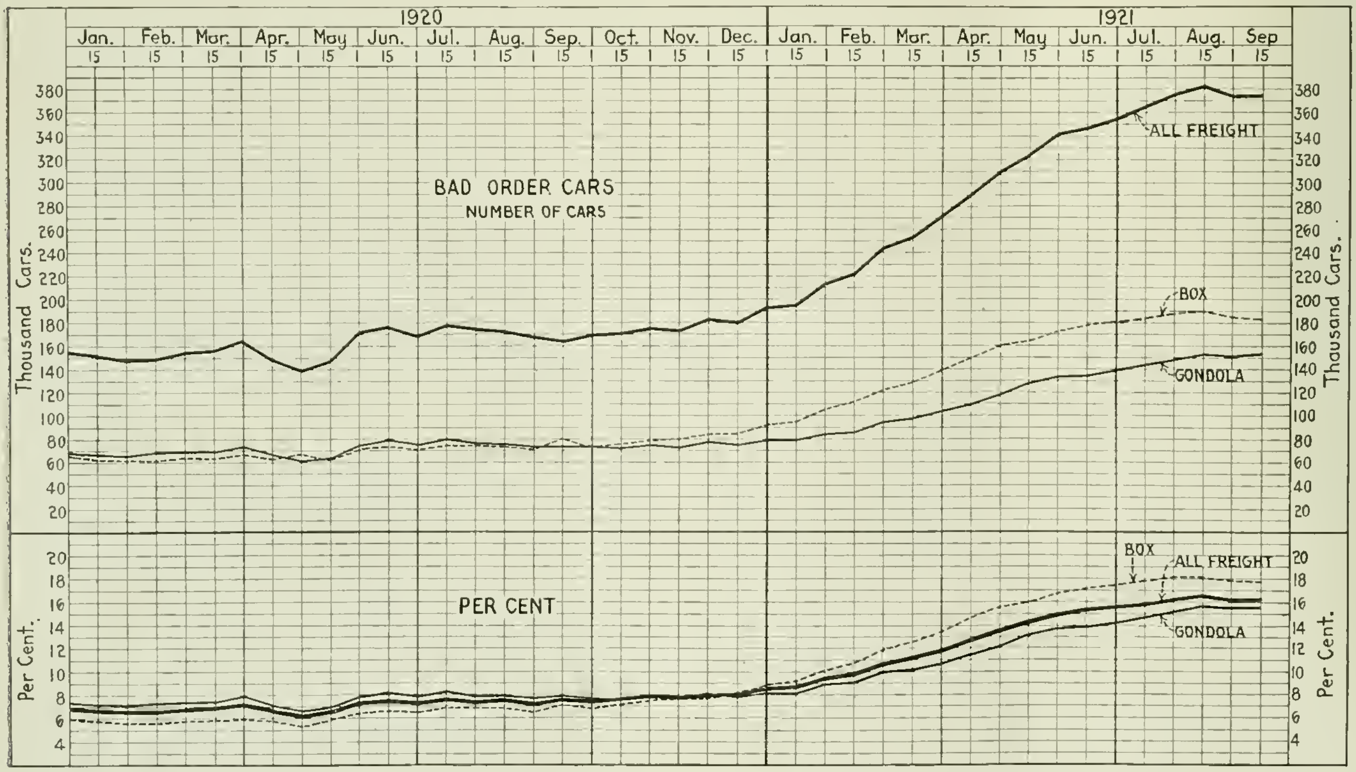
Will Traffic Increase or Decrease?

It is impossible to forecast what may take place during the last months of the year. Ordinarily there is a sharp decrease in traffic commencing about the last week in October and continuing until the end of the year. There are apparently no unusual conditions that would change the tendency very decidedly, although the resumption in the iron and steel industry, which is an important source of tonnage, may cause the decrease to be less rapid than in previous years.

Statistics of Car Supply, Traffic and Time Per Trip, 1920 and 1921

	1	2	3	4	5	6
Date 1920	Cars on line	Bad order cars	Surplus	Net in revenue service 1—(2+3)	Weekly car loadings nearest to 1st or 15th	Weeks per Trip (4÷5)
Jan. 1	2,263,541	153,995	......	2,109,546	744,969	2.83
15	2,260,266	151,196	......	2,109,070	865,992	2.44
Feb. 1	2,290,807	147,999	......	2,142,808	780,455	2.75
15	2,289,618	149,593	......	2,140,025	868,673	2.47
March 1	2,307,060	153,727	......	2,153,333	774,297	2.78
15	2,278,066	155,107	......	2,122,959	796,566	2.67
April 1	2,309,449	164,660	......	2,144,789	801,588	2.68
15	2,280,207	149,568	......	2,130,639	584,089	3.65
May 1	2,299,124	139,786	......	2,159,338	772,908	2.79
15	2,263,115	146,979	......	2,116,136	784,044	2.70
June 1	2,356,652	170,493	......	2,186,159	768,974	2.85
15	2,335,299	175,258	......	2,160,041	869,142	2.49
July 1	2,344,359	168,589	......	2,175,770	839,629	2.59
15	2,330,780	176,672	......	2,154,108	923,968	2.33
Aug. 1	2,344,812	174,371	......	2,170,441	914,128	2.37
15	2,298,581	171,773	......	2,126,808	962,352	2.21
Sept. 1	2,298,295	166,148	......	2,132,147	947,743	2.25
15	2,176,532	163,710	......	2,012,822	983,913	2.05
Oct. 1	2,278,273	167,965	......	2,110,308	975,946	2.16
15	2,264,258	168,888	......	2,095,370	1,005,563	2.09
Nov. 1	2,273,792	174,276	......	2,099,516	973,120	2.16
15	2,267,047	174,189	......	2,092,858	880,528	2.37
Dec. 1	2,279,573	182,097	30,022	2,067,454	872,162	2.37
15	2,246,512	179,445	91,472	2,075,595	796,858	2.60
1921						
Jan. 1	2,251,173	191,234	193,925	1,866,014	598,905	3.12
15	2,252,432	194,113	286,462	1,771,857	709,888	2.50
Feb. 1	2,265,502	213,180	323,376	1,729,046	699,936	2.47
15	2,267,238	220,420	392,162	1,644,656	681,627	2.42
Mar. 1	2,273,033	243,586	412,800	1,616,657	658,222	2.46
15	2,268,585	252,824	423,815	1,591,946	702,068	2.27
Apr. 1	2,281,986	270,319	495,781	1,515,886	666,642	2.28
15	2,275,484	289,771	499,248	1,486,465	703,896	2.12
May 1	2,289,282	309,971	482,076	1,497,235	721,997	2.07
15	2,288,242	324,969	450,164	1,513,109	750,158	2.02
June 1	2,301,749	341,337	393,701	1,566,711	787,237	1.98
15	2,302,724	346,861	381,526	1,574,337	780,741	2.02
July 1	2,300,155	354,611	373,128	1,572,416	774,808	2.03
15	2,295,660	365,092	370,787	1,559,781	776,252	2.01
Aug. 1	2,302,304	376,417	327,876	1,604,011	796,570	2.02
15	2,300,929	382,440	282,213	1,636,276	808,965	2.02
Sept. 1	2,303,669	374,087	246,001	1,683,581	830,601	2.03
15	2,298,383	374,431	219,267	1,704,685	853,762	2.00

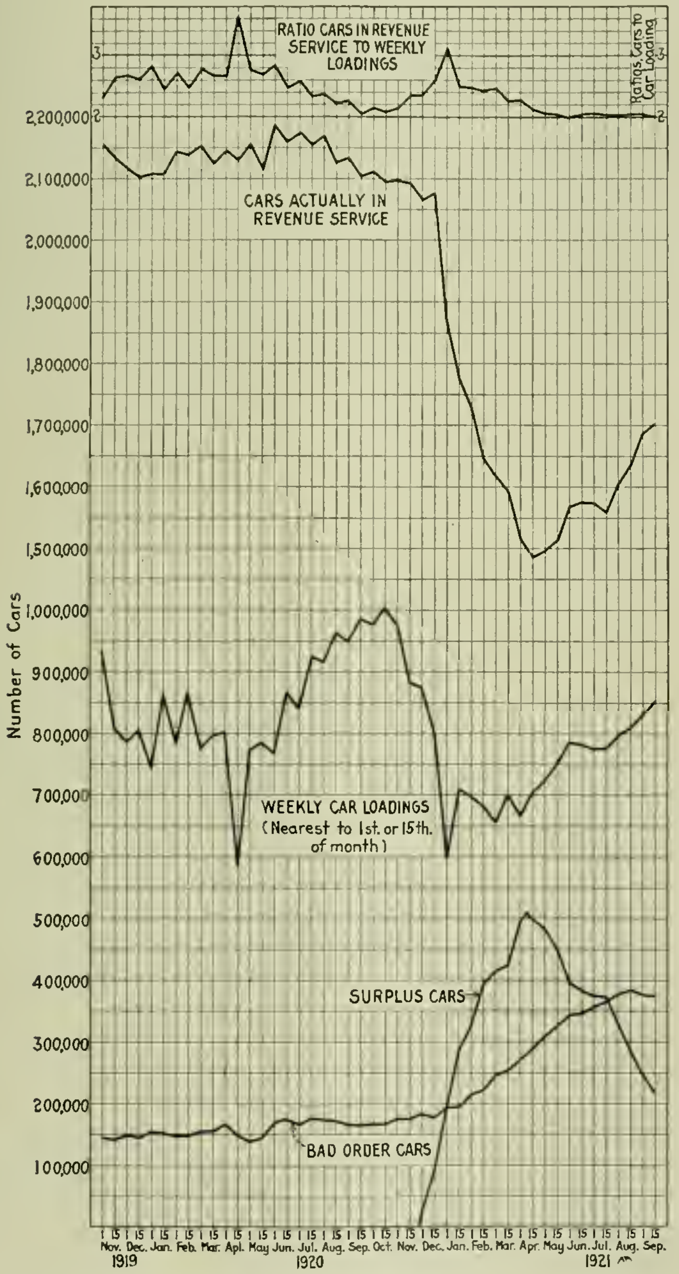
On account of the very light traffic there has been a surplus of cars throughout the year even in spite of the large number of cars that were on the bad order tracks. During recent months, however, the surplus has been decreasing rapidly. The maximum surplus reported was on April 8 when the



Bad Order Cars as Reported Semi-Monthly, January 1, 1920, to September 15, 1921 excess of idle cars over unfilled orders for cars amounted to 507,274; on September 8 this had decreased to 219,267. Over one-half of surplus, or about 118,000 cars were coal carrying cars. Although the railroads have more box cars than coal cars, the surplus of box cars was only 62,000.

Efficiency of Operation Affects Demand for Cars

The demand for cars varies not only with the traffic, but also with the performance that is made by each individual car, as measured by the ton miles of traffic handled over a given period. There are numerous factors entering into this statement and in order to get a clear conception of the conditions, it is advisable to analyze each factor separately. The three factors that directly influence car performance are: first, the percentage of loaded mileage to total mileage; second, the miles moved per day per car, and third, the average net revenue load per car.



Variations in Car Conditions and Performance During the Past Two Years

Normally about 70 per cent of car mileage is loaded mileage and 30 per cent is empty movement caused by lack of traffic for the back haul on certain classes of cars, or the necessity for returning cars empty to the home line. During the entire year 1921, the empty car movement has been abnormally heavy chiefly because of the effort that has been made to get cars back to the home road in order that they might be overhauled. During January, the empty mileage was 42.5 per cent of the total. In other words, instead of an empty movement of approximately 43 per cent of the loaded movement as occurs under normal conditions, the empty mileage was 75 per cent of the loaded mileage. During the latter months the ratio decreased but even in July 36.7 per cent of the total movement was empty car miles.

The miles per car per day varies considerably with the fluctuation in traffic, being high when all the cars are in use and falling when large numbers are standing idle on side tracks. It is also affected to some extent by congestion and delays due to the condition of the weather or other causes. During the past five years the figure has varied from 29.0 to 19.4 miles per day. During the heavy traffic of last fall, it was about 28 miles although efforts were made to increase it to 30 miles per day. Since business has fallen off, the daily car movement has decreased considerably and in July was only 21.6 miles. This seems to indicate a serious falling off in the efficiency of utilization of cars, particularly when considered in connection with the abnormally high ratio of empty mileage to total mileage.

The third factor influencing the amount of tonnage handled per car is the average load. During 1918 and 1920 when special efforts were made to increase loadings, an average of slightly over 30 tons per car was obtained. Since the first of the year the average load has decreased and now stands at about 28 tons. Normally there is less fluctuation in this figure than in the miles per day, the minimum value for any month in the last five years being 25.6 tons. The present performance is fairly creditable considering the great reduction in the tonnage of coal, ore and other bulk products being moved.

Car Performance Affected by Surplus and Bad Orders

If the standards of car performance are set at 30 per cent empty car mileage, 30 miles per car per day and 30 tons per car, neglecting the effect of bad order and surplus cars, each car should produce 630 ton-miles per day. In the seven months ending July 31, 1921, the net ton miles per car day were only 375 as compared with 472 in 1920. For the month of July the figure was 376 as compared with 526 in 1920.

In analyzing the performance of cars at the present time, it should be borne in mind that the statistics are based on the total number of cars on line. Thus the miles per car per day and the ton miles per car per day made by the cars actually in service are considerably greater than given above because of the large number of cars bad order or standing idle. Thus the statistics for July show that out of 2,440,792 cars on line, there were 375,769 bad order and 370,000 additional surplus of idle cars.

Deducting the bad orders and surplus cars from the total on line, it is found that only 1,694,000 cars or 69.5 per cent of the total were actually in use moving the traffic. These cars that were being moved were moving 31.1 miles daily and producing 541 ton miles per day. Comparing this with the average value for 1920 it is evident that excellent performance is being obtained from the cars that are actually in service and the unfavorable average is due solely to the large percentage of equipment that is idle.

Quick Movement Reduces Number of Cars Required

Another interesting measure of the rate at which cars are being moved is afforded by a comparison of the cars in service with the number loaded weekly. This gives approximately the number of weeks required for a complete trip and is plotted on one of the charts, from November, 1919, to date.

By referring to the chart it will be noted that the time per trip is roughly an index of the amount of traffic handled. The normal time is about two and one-half weeks, but during the heavy traffic of 1920 it decreased to slightly over two weeks. During this period the number of cars in service remained nearly constant. While weekly car loadings fell from 1,000,000 to 600,000, the time per trip increased to three weeks.

Commencing about December 1, 1920, there was a large increase in surplus and bad order cars. The result was to upset the relation between the volume of traffic and time per trip. From December to April, while there was little increase in traffic, the time per trip was gradually reduced to about two weeks. Since that time the number of cars in actual service has increased practically in proportion to the car loading and the time per trip has remained constant. Thus during the present period of light traffic cars are being turned with a rapidity that is ordinarily attained only under the stress of heavy traffic. This does not mean that trains are moving faster, for even while in service the average freight car is moving only about three hours per day. The decreased time results from more prompt dispatching in yards and quicker loading and unloading.

The principal significance of the present rapid movement is in relation to the future supply of cars. It will be noted from the chart that the car surplus has been decreasing rapidly. Between April 7 and September 15 it fell from 507,000 to 219,000. The reduction has been due solely to the increase in traffic, the time per trip remaining practically constant. At the present rate of decrease, the surplus would disappear entirely in a little over two months.

As has already been pointed out there may be a slackening in business at the end of the year, but other influences are likely to bring about a reduction in the car surplus. During cold weather there are always delays to trains and often serious congestion occurs at terminals and the time per trip is almost certain to increase. If only one extra day was needed to complete each trip, it would require 112,000 additional cars to handle the same amount of freight business. Thus an increase of two days in the time per trip would more than wipe out the existing surplus.

It may seem strange that the railroads have been able to handle traffic about 76 per cent as great as last year with only 69 per cent of the equipment actually in use. The explanation is to be found in the quick turning of the equipment. The figures make it clear that the existing surplus may be wiped out in a very short time. If a large increase in business should occur, the resulting congestion of facilities would slow down the movement and a serious shortage would be the natural result. Of course the revival of business may be quite slow, but past experience has shown that the most experienced railroad officers are often unable to foresee the trend of events and there is an element of danger in the present situation that makes it advisable to get the cars in condition as rapidly as possible in order to avoid a shortage later on.

Cost of Repairing Equipment

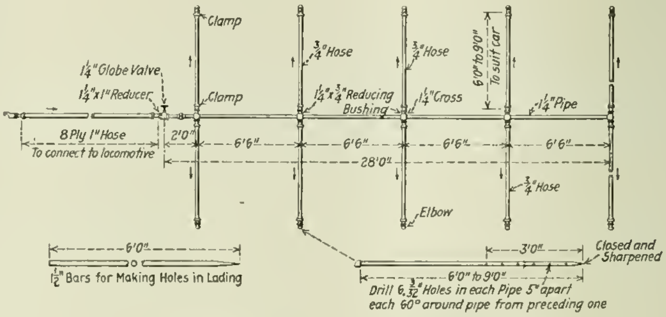
The present bad order situation is so extremely bad, it is safe to say that it presents a greater problem than the car department has ever faced before. Last year the railway executives set as a goal the reduction of the bad order cars to four per cent. The present figure is 16.3 per cent. Instead of 374,000 bad order cars, there should be only about 98,000. Some idea of the task involved in getting bad orders back to normal can be gained from the expense involved. As the basis for an estimate, it may be assumed that the bad orders will be reduced to four per cent by repairing all the light repair cars and all but 98,000 of the heavy bad orders. This will involve light repairs to 83,000 cars and heavy repairs to 193,000 cars. The light repairs are of minor importance and will be disregarded. The amount of work required on the heavy bad orders varies widely, but probably about one-half, or 97,000 cars, will require a general overhauling. The average cost of such repairs is $1,100 of which $605 represents the cost of material, $165 labor and $330 overhead. The total cost of general overhauling for these cars would therefore amount to $106,700,000, or more than one-fifth of the total expenditures for freight car repairs in 1920.

Thawing Frozen Hopper Cars

By E. A. Miller

During the winter months considerable trouble is often experienced in unloading hopper cars filled with coal, ore, slag, or other bulky commodities which have become frozen. It is only in exceptional cases that conditions warrant the expenditure necessary to build and equip a thawing house and therefore makeshifts are usually resorted to in loosening material from the cars. Sometimes considerable damage is done to the equipment when proper means for thawing are not provided.

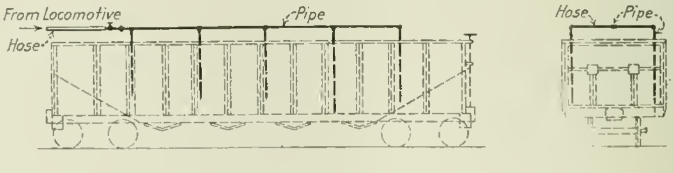
The arrangement illustrated herewith can be easily and quickly constructed and serves to loosen frozen lading in the minimum time and without injury to the cars. As the steam for heating can be taken from a locomotive, the device is applicable in practically any location.



Details of Thawing Device

The central portion of the thawing outfit is composed of four pieces of 1¼ in. pipe, four 1¼ in. crosses and a tee at the outer end. A 1¼ in. by ¾ in. reducing bushing is screwed into each side of the crosses. Leading from each of these bushings is a steam hose securely clamped to nipples at each end. Attached to the outer nipples are pipes 6 ft. to 9 ft. long. The length of the hose should be about the same as the pipe, which should be long enough to reach through the lading to the bottom of the car body. The lower end of each pipe is closed and sharpened and six 3/32 in. holes are drilled, as shown, in a spiral around the pipe.

For connecting to the steam heat line of the locomotive or tender, a 1 in. steam hose, about 50 ft. long, should be provided. One end should be fitted with a standard steam heat hose coupling while the other end should carry a 1¼ in. globe valve and a union so that the hose may be uncoupled from the thawing pipes whenever necessary. Steel bars, 1½ in. in diameter and about 6 ft. long, are used for making holes for inserting the pointed pipes in the frozen lading.



Arrangement of Pipes as Used in a Four-Hopper Car

One of the illustrations shows the application of the arrangement to a four-hopper car. The dimensions can, of course, be varied to suit any other types of equipment.

Successful Methods Used in Repairing Side Rods

Simple Gages Insure Accurate Standards; Methods of Procedure Which Simplify Work and Reduce Costs

BY M. H. WILLIAMS

REPAIRING side rods in the main railway shops has gradually grown to quite large proportions, so much so that the question of facilities and tools to expedite this work should receive careful attention. A number of devices, tools and methods that have been used in different shops and found to be of assistance when making these repairs are explained below.

One of the most important points at the time of repairs is that of laying out the center to center distance of the rod brasses correctly to the established standard called for on the drawings, this distance being the same as that between the axle centers. In order to insure these distances being correct, standards or tram bars for this purpose should be available readily in all shops where this work is done.

Tram Bar

A tram bar used for setting the adjustable points for laying off rod centers, laying off shoes and wedges, setting and proving distances between axle centers, etc., is shown in Fig. 1 and may be considered a master standard for this purpose. Such a tram bar will be found to be a decided improvement when compared with the practice of setting distances to a rule, scale or tape line. As the center distances for all classes of rods handled in a shop may be placed on one bar, this tram bar costs less than individual non-adjustable trams for each class of rod. The tram bar shown may be made of 2 in. by ½ in. steel about 8 ft. long. Hardened steel bushings about ¼ in. outside diameter with a 1/16 in. hole drilled in the center about ¼ in. deep are set into this bar at proper locations. At *A* is shown the zero bushing that is always used as one of the setting points—the remaining bushings as shown at *B*, *C*., etc., being located a distance from the zero point equal to the standard distance center to center of rod sections. The class of locomotive and rod section are stamped on the bar near the latter bushings for the purpose of indicating them. For example, if locomotives known as 2-8-2-A require a distance of 54 in. for the front section of the rod, the bar is stamped 2-8-2-A FRONT at this place. Another for an intermediate section may be distant 58 in. and stamped 2-8-2-A INT., and so on.

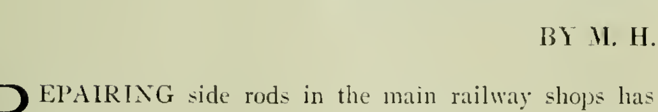


Fig. 1—Tram Bar

This bar offers a ready and accurate means for setting adjustable tram points used for the tramming of rods and wheel centers or for checking solid trams if they are used. Having a standard of this nature available will reduce the errors that are liable to occur from improper setting of tram points. These tram bars generally are bolted to walls, or work benches at convenient locations in the rod shop, the erecting shop and engine houses.

Correcting Center Distances Between Holes

A number of methods are followed when repairing side rods in the event of the distances from hole center to hole center varying from the standard, the manner of doing this depending upon the machinery available. Either of the two plans mentioned have certain advantages and disadvantages. If the distances between centers are not standard, the first method is to rebore the holes for bushings at the correct distance of hole center to hole center. Where there is only a small error, say not over ⅛ in. the method often followed is to press the brasses into the rod and afterwards bore them to agree with the standard tram distance. In this event the bore of the brasses will be eccentric with their outside but the distance between centers will be correct.

If the first mentioned method is used and the rods are bored each time they are found to be out of tram, repeated borings may in time enlarge the holes to the danger point. This, however, is offset by the fact that where the rod is kept to a standard tram distance the brasses may be turned on the outside and bored in one chucking operation, and when necessary to renew a brass the machining may be done in an ordinary lathe, which is quite an advantage in small shops not well equipped.

The second method of pressing the brasses into the rod and afterwards boring has the advantage that it is not necessary to rebore the rod as often and the holes are not enlarged as by the first method. The disadvantages are that when necessary to renew a brass it must be turned to the proper outside diameter, pressed in the rod and the hole bored on a drill press, special rod boring mill or some machine where the boring bar revolves. This is often difficult in the smaller shops not equipped with suitable machines. However, make-shifts are at times resorted to, such as turning the outside of brasses to correct size in a lathe and then setting the brass the required amount eccentric in the lathe chuck and boring the hole to the required size. This plan is not recommended and is only mentioned to show to what extremes it is sometimes necessary to go to in railway work. Considering the question of renewals of brasses as a whole the second plan of boring while in the rods appears to be the more economical and satisfactory.

Refinishing Holes in Rods

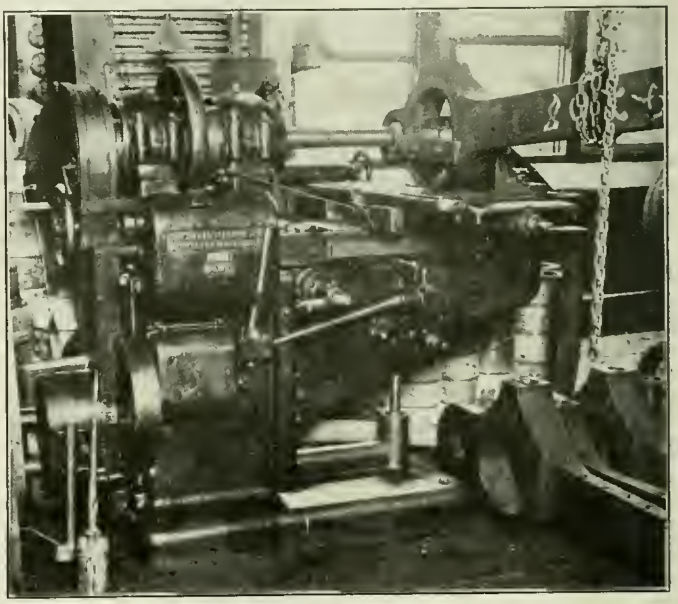
When refinishing rod holes they should be enlarged the least amount necessary to true them up and obtain a satisfactory hole. To remove a greater amount of metal will result in unnecessary enlargement and a sooner approach to the danger point where the rod must be scrapped. The question also comes up as to when a hole in a rod is out of round or irregular enough to warrant reboring. Looking at this from a safety standpoint and also that of true brasses would indicate that the bore should be trued when more than 0.015 in. out of round for a 7 in. or less diameter bore, and for larger holes the same ratio should be followed.

Several methods are followed when truing these holes, one of the more common being to rebore on a special boring mill or drill press, the rod being clamped to the bed of the machine and bored with an adjustable boring tool. The cutters are held in the bar by set screws and adjusted in or set out as may be necessary to obtain the required diameter. This method, where care is used and the drill press or boring mill is in proper condition, will result in good work. It has the disadvantages, however, that there is always the possibility of the workmen removing more metal than necessary, and, unless the machine is in a first class state of repair the holes will not be regular owing to the bar following the irregularities of the original hole. These conditions are improved by making use of a pilot bar working in a bushing in the machine table. This, however, is objectionable on account of the time required to set the rod central with the bushing in the table. The double cutter adjustable boring bar similar to that used for boring car wheels is also used for this purpose and in many respects is superior to a bar in which the cutter is held by a set screw.

One of the best and most up-to-date methods of doing this work is to grind the rod holes on a Heald or similar internal grinder. With this machine the rod is clamped to an angle plate hold on the machine table. The table is then set by means of the table adjusting handles similar to adjusting a milling machine table so that the hole in the rod is central with the grinding wheel rotation. The grinding operation is then performed which consists of truing the bore only enough to remove irregularities and not enlarging the hole more than absolutely necessary. On account of the small amount of time required to clamp, adjust and grind the total time to finish a hole will generally be less than when bored. On account of its many advantages this form of machine is strongly recommended for this class of work.

Measuring Sizes of Rod Holes and Brasses

Several methods are used for measuring the diameter of the holes for rod work. This usually has been done in the past with machinist's calipers, the amount allowed for the force fit of the brass in the rod and the amount the bore of the brass was made larger than the crank pin being a question of the skill and judgment of the workman. The modern method for taking these measurements is to use micrometer calipers. By their use the diameter of the holes is measured at various angles and should the bore not be regular the average diameter may be calculated and followed. Such measurements will show the exact amount a hole is out of round or irregular, and where standards have been set governing this matter the necessity for reboring will at once be settled by the difference in these measurements. Also when machining the brasses, they are made a definite amount larger than the rod bore in order to insure a correct force fit. No standard practices appear to have been determined for force fits for rod brasses but on some roads from 0.002 to 0.003 in. is allowed for each one inch diameter of rod bore.


Grinding Knuckle Pin Hole

Size for Rod Bore

Practically every rod brass must be bored to a different diameter owing to the wear of the crank pins on which they are to work. In order to insure the bore being correct and to avoid the necessity for the boring mill operator leaving his station to go to the driving wheels and take crank-pin sizes, it is the practice in some shops to measure the crank pins with micrometer calipers and set down the sizes on a specially prepared blank or memorandum. The boring mill operator then bores the holes a suitable amount larger than the sizes given to allow for a running fit between the crank-pin and brasses.

Crank-Pin Sizes

Crank-pins that have been in service are often found to be out of round or tapered as a result of wear. However, a slight discrepancy in diameter will not justify removal or refinishing. It is an open question how much crank-pins may be worn before repairs are necessary. On some roads they are not repaired until they are more than 1/32 in. taper or out of round which appears to be a good practice. When measuring the pin diameter the largest size measured is used when determining the diameter for boring the brass.

Tramming Rods

Practically all side rods when in the shop for repairs should be trammed in order to insure the distances between hole centers being correct. This generally is done in the following manner. The rod sections are laid in a straight line on a trestle or some convenient place and coupled up with the knuckle pins. Pieces of wood about ¾ in. square are cut to the proper length to fit the rod or brass bore and fitted tightly in place—these wooden blocks having tin tacked on one side for marking upon. In other cases adjustable centers are used. Both of these devices are shown in Fig. 2. The centers of the holes in the rod or brasses are then laid off on the surface of the tin tacked to the wooden blocks or the adjustable centers set and the distance between the two centers checked with tram points that have been set to the standard tram bar. Should the distances not be correct the centers marked on the tin face are altered to agree with the tram and circles are marked around each hole to serve as a guide when reboring and proving the accuracy of the work.

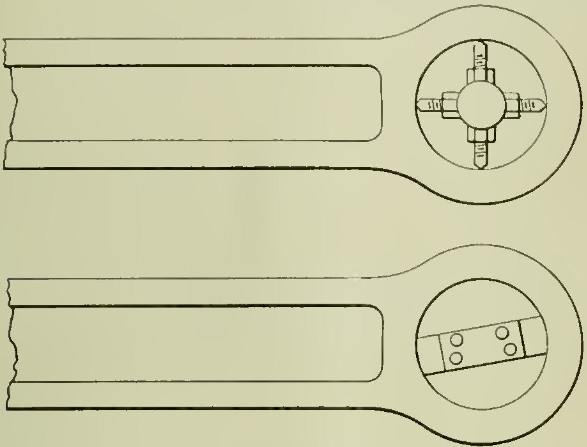


Fig. 2—Centers for Tramming Rods

When laying out for brasses that have been previously pressed in a similar plan is followed, the circles being scribed on the brasses and the bore then made exactly concentric with these circles.

Fitting and Boring Rod Brasses

Where it is the practice to rebore the holes in rods and restore the correct distance, the brasses are turned on the outside to a proper diameter for a force fit in the rods and also finish bored to a size suitable for a running fit on the crank-pin. When following this practice allowances are made for the closing of the bore of the brasses when pressed into the rod, this closing being from 25 to 75 per cent of the amount allowed on the outside for a force fit. Exact allowances readily can be made by the use of micrometer calipers and a proper fit obtained between the bass and the crank-pin. Where the brasses are bored while in the rod, the operation is similar to that described for boring rods and the same style of boring bar is used, the bore being made in the exact center of the circle scribed on the brass.

Refinishing Knuckle Pin Holes

The limited space that can be given for side rods has made it necessary in many cases to design the knuckle pins and bushings smaller than is desirable. Therefore, the fitting of the pin and bushing should be as nearly perfect as possible, for, unless this work is properly done these parts will loosen in service and cause trouble. In order to obtain the desired grade of fitting too much stress cannot be placed on the question of maintaining the reamers used for this purpose to the proper taper. The holes when reamed should be as near perfect as possible to insure a full bearing for the pin instead of only bearing in spots. Such conditions being essential the next question is how to meet them.

Accurate gages of a design which admits of quickly inspecting the taper holes results in a higher standard of rod reaming. It is a good practice to check each rod with a gage at the completion of the reaming operation to detect at once errors such as may occur as a result of wear or improper grinding of reamers, reamers running out of true in the drill press or from other causes. This inspection together with proper reamer maintenance results in ultimate economy owing to the reduced time required when machining the knuckle pins as one setting of the taper attachment of lathe or table of grinding machine will answer for the entire lot of pins of the same taper and eliminates the many trial fittings of pins now common where gages are not used.

Gages for this purpose are made in a number of forms. For convenience when handling, detecting errors in taper of holes, and measuring their diameter the flat form shown in Fig. 3, has been found satisfactory. This form weighs less than the cylindrical form which is a desirable feature and slight errors are more readily detected. This gage is made from tool steel hardened or soft steel case hardened. The taper per foot is the same as that of the rod to be measured, the thickness about ⅜ in. and the small end diameter the same as the small end of the taper of standard rods made to drawing sizes, i. e., when placed in the rod the point will come flush with the lower side. The length is governed largely by the amount that the taper holes may be enlarged without endangering the safety of the rod. As an illustration assume that the small end of the taper hole in the rod is 3¾ in. diameter, that this diameter may be increased ¼ in. or to 4 in., that the taper is ¾ in. per ft. and that the out to out thickness of the rod is 4 in. The taper of ¾ in. per ft. equals 1/16 in. per inch length. Therefore for ¼ in. enlargement of the hole the gage must be 4 in. longer than the thickness of rod. Consequently, for the rod in question, the gage should be about 9 in. long to allow for 4 in. width of rod, plus 4 in. that the gage will extend through a large reamed rod, plus about 1 in. for hand hold.

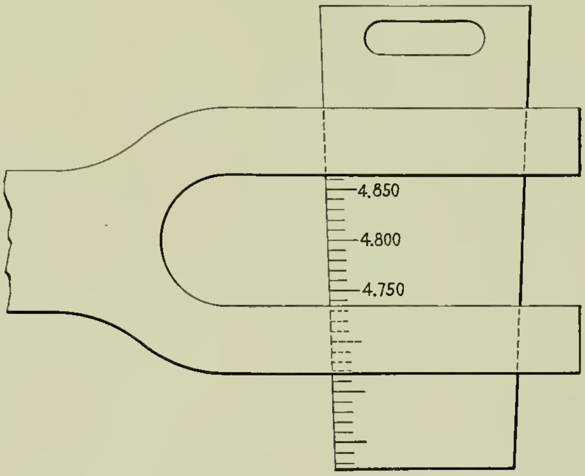


Fig. 3—Taper Gage for Knuckle Pin Hole

It is desirable when finishing the taper ends of knuckle pins to know their exact diameter at some particular point. This is measured easily by gages of this design when one edge is graduated and stamped to show the actual diameters of the taper surfaces. Generally speaking these are graduated to show each 0.010 in. increase in diameter, i. e., if the first line indicates 3¾ in. or in decimals 3.750, the diameter at the next line will be 3.760 in., the next 3.770, etc. The correct spacing of these graduations can be calculated readily for any taper required. With the gage in question having a taper of ¾ in. per ft. (equal to 1/16 in. per in. or a ratio of 16 to 1) the distance from graduation to graduation for 0.010 in. increase will be 0.010 multiplied by 16 or 0.160 in. Therefore these graduations should be placed this distance apart and for the rod in question they should be extended for about 4 in. making 25 graduations.

Use of Knuckle Pin Gage

The general practice when inspecting taper holes is as follows: After placing the gage in the hole it is given a slight rotary motion, say ⅛ turn, to center it in the hole so that its center line will assume the position of the true center of the hole. Next the large and small ends are each tried in turn for side or rocking movement. If there be an absence of side movement at both ends this proves that the reaming is correct. Should there be side movement at the large or small end, however, it shows that the hole is not properly reamed. A slight error in taper being quite perceptible by this side shake, the rods may be inspected more quickly than by the customary cylindrical gages. When the gage is placed in the taper rod hole the graduation nearest the inside of the smaller jaw is noted and the actual diameter read direct from the gage, this size being used when finishing the taper end of the knuckle pins.

Fitting Knuckle Pins to Side Rods

It is not the purpose to explain the process of manufacturing these pins, it being assumed that they have been blanked out in the central production shop or point of manufacture, that extra metal has been allowed for the final fitting to the taper ends, that the straight or bearing surface has been finished to standard gages, and that the pin has been threaded, drilled and all work done so as to reduce the rod shop fitting operation to the lowest limit, and thus practically confine their work to the taper ends.

It is a question if any machine will be found as accurate and economical as the plain cylindrical grinder for finishing the taper ends of these pins to fit the rod. This machine has the advantage that either hardened or soft pins may be finished equally well. Therefore the pins may be hardened in quantities during the course of manufacture. Where the work of fitting is done on these machines the method is as follows. The grinding machine table is adjusted to the taper requi ed, such as ¾ in. or 1 in. per ft., this taper being set approximately correct from the graduation and afterwards given the final setting from the trial grinding.

The first operation when fitting the pins is to measure the diameter of the taper hole in the rod with the taper gage as has been explained, the size being taken at the inside of the smaller jaw. When grinding, the smaller of the two tapers is first ground to the size shown by the gage plus 0.001 in. to 0.002 in. to allow for drawing up, the diameter of the taper surface being measured with micrometer calipers as shown in Fig. 4. After the required size is obtained, the micrometer dial on the grinder, or the throw-out stop governing the in-feed of the grinding wheel is set to the throw off stop or zero mark and the grinding operation is then transferred to the large end. When grinding this end the wheel is fed in to the previous setting of the throw-off stop or zero mark. This results in the two ends being to the same taper and, where the machine is properly set and the pin size measured correctly the pin will fit the hole in a satisfactory manner. With an operator accustomed to this work 90 per cent of the pins will fit the rod at the first trial. As the taper ends of knuckle pins are comparatively short it is the usual practice to use grinding wheels slightly wider than the surface to be ground, the wheel being fed directly into the work without lateral motion. The accuracy of this work is governed to a large extent by the size, weight and rigidity of the grinding machine. Therefore, machines smaller than the size known as 10 in. by 36 in. are not recommended.

Where grinding machines have not been installed, this machining on soft pins is done in a similar manner by turning on a lathe, making use of the taper attachment and measuring as explained.

It will readily be noted that where the taper holes in the rods have been reamed to one taper a large batch of pins may be finished at one setting of the grinding machine table or taper attachment of the lathe and also that by the use of the gage by which the actual diameter of the taper hole can be measured, trial fittings common to cruder methods can be practically eliminated, resulting in saving considerable time.

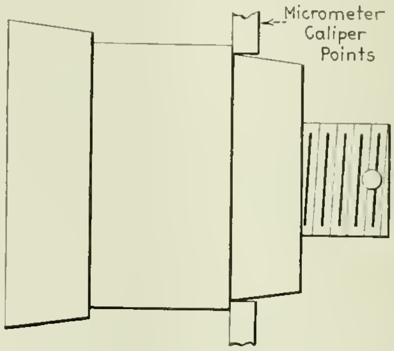


Fig. 4—Calipering Knuckle Pin

Fitting Knuckle Pin Bushings to Rods

It is assumed that these bushings have been made in the central shop the same as the pins, to as near a completed state as possible, that is, the blanked out, oil holes drilled, oil ways milled, case hardened inside with ends and outside soft, the bore ground to plug gages the correct amount larger than the pin body to allow for a running fit between the bushing and pin, or, if soft steel or brass bushings are used it is assumed that they have been semi-finished up to the same point. With bushings semi-finished as above, the work in the rod shop is confined to machining the outside to fit the rods.

In order to obtain a perfectly cylindrical bore in the bushings the bore of the rod into which they fit should be ground or reamed if out of true more than 0.010 in. When machining the knuckle bushings the rods are preferably measured with inside micrometers and the outside of the bushings turned or ground about 0.0015 in. larger per inch of diameter to allow for a force fit, the latter being measured with outside micrometers. The bushings are now ready to force into place which completes the rods.

Interchangeability of Knuckle Pins and Bushings

Mention has been made of pins having bodies ground to gage sizes and also bushings with the bore ground to plug gage sizes. This is somewhat of a departure from the conventional methods followed but it works out very well in practice. It must be borne in mind that these two must bear a certain relation to each other in order to insure satisfactory service on the locomotive. This relation can be obtained when manufacturing in quantities cheaper than where each pair is fitted individually. The customary plan with interchangeable manufacture is to make the pin bodies of each class to definite sizes, such as 4 in., 4⅛ in., etc., care being taken to allow only a small tolerance that should not be over 0.002 in. The bushings are ground, or, in the absence of grinders, bored and reamed about .012 in. larger than the pin diameter, maintaining the same tolerances. These limits are not difficult to live up to in quantity production. The bushings will compress a certain amount when pressed into rods which will reduce the diameter of the bore. This is a question that must be looked into for each class of rods in order to insure a proper running fit of the pin. However, with the amount the bore should be larger than pin once settled and these parts made to the required sizes all the work of fitting the pin to the bushings is removed from the rod shop and transferred to the manufacturing department where it can be done at less expense.

Malleable Castings Improved by Research

The American Malleable Castings Association inaugurated an intensive research program a few years ago in order to improve the quality and reliability of its product which at that time was unfortunately frequently of a very uncertain character. A central laboratory was established and Enrique Touceda, Albany, N. Y., was engaged as consulting engineer and metallurgist. With the aid of a corps of assistants and inspectors investigation was made of the foundry practices of the different members and improvements made as rapidly as investigation demonstrated their value. Test bars were regularly submitted by all manufacturers. Bulletins containing reports, and recommendations were sent out periodically.

As a result of this work malleable castings as at present manufactured in conformity to association standards, instead of being of uncertain quality and lacking in uniformity, are of the highest quality and integrity. They are on a plane of dependability with the best mild steel castings or forgings, while they can be machined at almost double the speed of either.

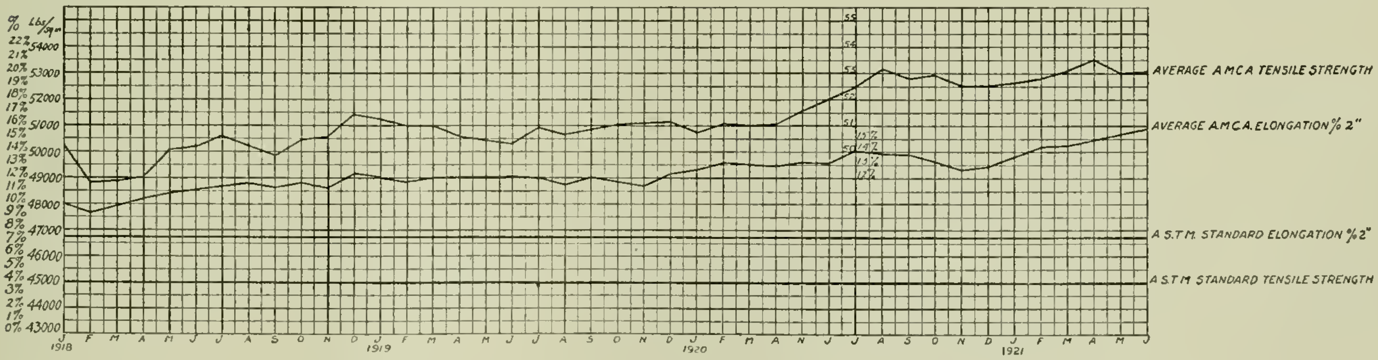
A bulletin just issued shows the most marked advance in development has been made in the past three and one-half years, during which period the product of association members as a whole has increased from an average somewhat under 49,000 lb. per sq. in. ultimate tensile strength to over 53,000 lb. and from an average elongation under 10 per cent in two inches to nearly 16 per cent.

The bulletin covers the report of bars tested by the consulting engineer for the month of June, 1921, when the highest average percentage of elongation of the association as a whole was attained, namely, 15.77 per cent in two inches, or over twice the elongation required by the American Society for Testing Materials in its standard specification for malleable cast iron. Since elongation, which is the measure of ductility, is the property on which malleability depends, it will be seen that this report marks a new high level in the research program. Since the first of the year, the rise in percentage of elongation has been steady and uninterrupted, and has increased a full two per cent. The high water mark for average ultimate tensile strength was reached in April of this year when the figure of 53,530 lb. per sq. in. was recorded. The June value for this property was 53,038 lb. or 8,000 lb. in excess of the A. S. T. M. requirements.

A reference to the accompanying chart showing average ultimate tensile strength and elongation for the product of the membership as a whole for 1918, 1919, 1920 and the first six months of 1921, indicates clearly how these two properties have increased during this interval. The average of both properties has always been well in excess of the A. S. T. M. standard requirements of 45,000 lb. per sq. in. tensile strength and 7½ per cent elongation in two inches. It is clear that this margin when added to the factor of safety already included in the standard specifications, offers exceptional safeguards to the user of those malleable castings furnished by a majority of the members of the association.

A study of this chart will show that during the year 1918 there was recorded a gradual increase in both tensile strength and elongation, with a slight retrogression from July to October. During 1919 and the spring of 1920, both properties remained fairly constant, averaging around 51,000 lb. tensile strength and 12 per cent elongation. From April, 1920, to August of the same year, both properties increased to values never before reached, the tensile strength increasing from 51,000 lb. to over 53,000 lb. when a slight depression set in extending to the month of November, since which time the increase has been regular with one slight interruption in tensile strength. It will be noted that the two curves run fairly parallel, rising and falling together, a characteristic of malleable iron which is rather unusual for ferrous materials, the reverse normally being true.

The constancy in the average values of these properties maintained throughout 1919 and the spring of 1920, with little apparent improvement over a period of several months, is accounted for by the fact that during that time twenty-two new plants were added to the list of test bar contributors. None of these had previously profited by the research work, and their submitted test bars in most cases had the effect of lowering the general average of the association, until after such time as the effect of the new influence began to assert itself. The same effect was felt from August of 1920 to December, when four new contributors were added. No new contributors were added from April, 1920, to August of the same year, nor during the period from December of 1920 to June of this year. This fact taken in conjunction with the improvement in quality of the new contributors through the assistance of the consulting engineer and his corps of visiting inspectors, had the effect of a steady and rapid increase in both physical properties. The slight retrogression in the



.. Average A. M. C. A. Ultimate Tensile Strength and Elongation by Months average values of both properties marked by the dropping of the curves from August to November of 1920, is explained by the difficulty in getting good pig iron and coal during that exceptional period of demand for all commodities.

Another interesting fact is the high percentage of perfect scores made by the members of the association. By a perfect score is meant the ability of every bar submitted by a member to equal or surpass the standard specifications of 45,000 lb. tensile strength or 7½ per cent elongation in two inches. In June of the present year 87 per cent of the contributors made perfect scores. Comparing this record with those for the same month of the previous years, it is found that perfect scores were attained by but 29 per cent of the contributors in June of 1918, 57 per cent in 1919, and 74 per cent in 1920. Out of a total of 31 contributors in June, 1918, of whom 29 per cent attained perfection, all but one made perfect scores in June of the present year. Only 2.53 per cent of all bars cast and submitted for test during June failed to pass the standard A. S. T. M. specifications as against 15.12 per cent for June, 1918.

This general improvement of the product of all members is reflected in the number of certificates that were awarded for the quarter ending June 30; sixty-one plants having been awarded the coveted certificate, the highest number yet issued for any one quarter. The awarding of a certificate is not based upon the test bar record alone; the general plant practice as reported by the consulting engineer's corps of inspectors being considered in its effect upon the product. Through this safeguard, the purchaser is assured that the test bar record of each day's production can be considered as truly representative of the castings. Castings furnished by certificate holding plants are designated as "certified" malleable castings.

Nothing could more clearly indicate the value of a research program consistently carried out and rigidly applied than a comparison of this most recent report with those that have preceded it. The net result of this work has been to raise to a high level the standards of a great industry, and to increase materially the commercial applications of its product.

Feed Valve Testing Device

BY NORMAN McCLEOD

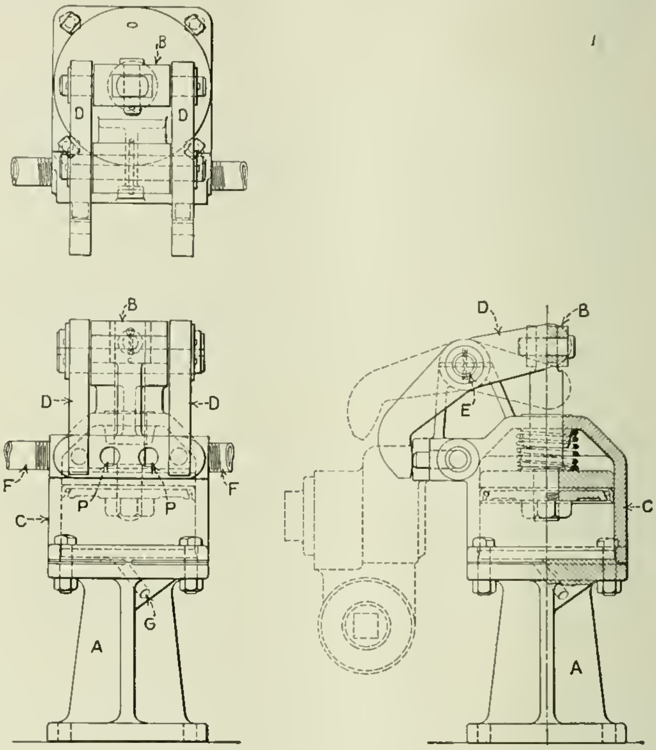
The testing of feed valves used in air brake service, after they have been repaired has been accompanied with more or less annoyance inasmuch as it requires more dexterity than the average man possesses. To save time in applying and removing feed valves from the testing rack the device, illustrated, has been developed and used with good success.

The device consists of a cast iron base *A*, fastened permanently in a vertical position to the air brake test room bench in a position where it can be connected to the testing equipment through pipes *FF*. Provision is made to cut these out of service if need be by having ½-in. globe valves or cocks located on each side of the device. The top of casting *A* is machined to receive a 3½-in. bore cylinder *C*, provided with a piston, follower head, distributing valve packing leather and spring, all being taken from the standard stock of air brake parts. Attached to the outer end of the piston rod is a cross bar *B*, on each end of which are two lever clamps *DD* which oscillate on shaft *E* which is in turn supported on a projection forming part of the cylinder casting.

At the side and near the top of the stroke of the piston, on the cylinder casting, a projection is provided with two portholes *PP* and dowels to correspond to the bolt holes in the face of the flanged rectangular face of the feed valve.

The main idea of developing this device was to facilitate the holding of the feed valve in place while the operator was looking after the test, reading gages, etc., which could not well be done if the operator had to hold the valve against a fitting or lose time tightening and loosening nuts.

With this device, the operator places the feed valve bolting flange with the bolt holes over the dowels on the tester, thus bringing the ports in the machine and valve in line (a permanent metallic gasket being always on the machine). With the other hand the operator opens a ¼-in. air cock located at or near *G*, this cock being connected to the air pressure system. This piston is then forced outward a distance of 1⅛ in., pushing the cross arm *B* which in turn takes the two lever clamps *DD* with it. This causes the lower ends of the clamps to press hard against the flange of the feed valve and hold it tight enough to form an air-tight joint, thus holding the feed valve in place while the operator subjects it to the usual prescribed test.



Feed Valves are Readily Clamped on This Device for Testing

Upon closing the small valve referred to above, the coiled spring forces the piston back to open position, the exhaust air passing out of a porthole provided for the purpose in the cock or valve. In the meantime the feed valve has been released. This feed valve testing device has proved a great source of convenience as well as a great saver of time and money.

Henry Ford's entrance into the field of steam railway transportation, through his acquisition of the Detroit, Toledo & Ironton, has aroused a more intense public interest than any other single recent event in railroad history, not excepting the advent of federal control at the beginning of 1918. His success as a manufacturer in a field in which, through great ability and highly standardized factory methods, he has built up a vast business, has given him an international reputation such that his opinions on any industrial subject are received with great respect by the public.

Mr. Ford has purchased a railroad which never before had demonstrated that its existence as a common carrier was economically justified. He raised the wages of his railway employees when other roads were adopting reduced wage scales. He has made a 20 per cent reduction in local freight rates and has started a movement for a general rate reduction.

A View of the Exhibit at the Steel Treaters' Convention

Steel Treaters Meet at Indianapolis

Convention Featured by Large Attendance, Interesting Papers and a Comprehensive Exhibit

THE Third Annual Convention of the American Society for Steel Treating was held in the Manufacturers' and Women's Buildings, State Fair Grounds, Indianapolis, Ind., September 19 to 24, inclusive. Prominent metallurgists and steel treaters both of the United States and Europe were present, the total registration of delegates, visitors and guests being well over 4,000. Eighty-seven papers relating to steel treating in its various phases were read and presented by title, simultaneous sessions being held on several afternoons to allow time for reading and discussing the large number of papers. The exhibition was of exceptional size, interest and value, approximately 80 manufacturers exhibiting heat treating equipment and products ranging from immense electric and gas furnaces to small scleroscopes, steel drills and cutlery.

The entertainment program was featured by a 50-mile match race Wednesday morning on the Motor Speedway, between Duesenberg and Frontenac motor cars. The race was exciting, being won by Wilcox in a Frontenac car at an average speed of 95.4 miles per hour. Another interesting feature was a smoker and vaudeville entertainment, Tuesday night.

The annual banquet was held Thursday night in the Riley Room of the Claypool Hotel, being presided over by Lt. Col. A. E. White, with Dr. Albert Sauveur as toastmaster. The speakers included Gov. W. T. McCray of Indiana; Hon. C. W. Jewett, Mayor of Indianapolis; H. E. Coffin, vice-president of the Hudson Motor Car Company and a member of the Naval Advisory Board, and others. The principal address of the evening was on "Our Air Policies and the National Defense," by Mr. Coffin, who said that the cornerstone of national security lies in peacetime industrial organization against a possible wartime emergency. "No nation, however warlike, will assail a nation known to have its industrial resources efficiently organized for defense," said Mr. Coffin. In connection with the address some interesting moving pictures of the aerial bombing and sinking of the German battleship Ostfriesland and other battle cruisers were shown.

The opening session of the convention was held Monday at 2 P. M., convention delegates being welcomed to the city by a representative of the Mayor. This address was followed by a response by Lt. Col. A. E. White, national president of the society, when the members listened to the report of tellers of the election. The following officers were declared elected for the ensuing year: F. P. Gilligan, Hartford, Conn., president; F. C. Lau, Chicago, 1st vice-president; R. G. Allen, Springfield, Mass., 2nd vice-president; J. B. Emmons, Cleveland, Ohio, treasurer; J. J. Crowe, Philadelphia, Pa., director. The holdover officers are Lt. Col. A. E. White, retiring president, who automatically becomes director for two years; W. H. Eiseman, Cleveland, Ohio, secretary; H. J. Stagg, Syracuse, N. Y., director; E. J. Zanitzky, Chicago, director. The reports of the secretary and treasurer were read, being followed by the address of Lt. Col. A. E. White.

President's Address

"I take pleasure in presenting for your consideration a statement of the work of the American Society for Steel Treating. I further take the liberty of incorporating in this report various recommendations and suggestions relative to the conductance of the work of the society during the coming years, to which it is trusted that your national and local officers will give due consideration.

"The year has been a most successful one for the Society. The combined membership at the time of the amalgamation of the American Steel Treaters' Society and the Steel Treating Research Society was approximately 2,750. On September 1, 1921, the membership of the American Society for Steel Treating was 3,237. This represents an increase of 487 members during the past 12 months' period, or an increase of substantially 18 per cent. Appreciating the unusual conditions which have existed during the period, a growth of this magnitude is both surprising and gratifying.

"Our chapters also have increased in number from 27 to 31, the new chapters taken in being in Syracuse, N. Y.; Charleston, S. C.; Worcester, Mass., and Gary, Ind. Our financial status is sound with a sufficient balance on hand to carry us over any untoward periods, should such develop.

"It is prerogative of the President at this one time to incorporate in his report such suggestions as he believes may be for the good of the Society. In this connection, I would bespeak an arrangement of this magazine (Transactions of the American Society for Steel Treating) so that it may cover more adequately even than it does today the field of heat treatment. It is my personal feeling that in its pages we should cater to the technical men and to the shop men. Our articles though not necessarily in the same contribution should be of interest to both and they should be arranged so that there will be no misunderstanding relative to the purposes for which the articles are prepared.

"There is an old saying, 'In union there is strength.' This seems to be the case with our technical societies, but I have noted where our chapters are in close alliance with other technical societies in their own communities there is always a successful chapter. Further, I have noted that our weaker chapters are for the most part those which exist in communities where there is no bond of union between the technical societies. In view of this condition I therefore strongly recommend to the various chapters in the society that they make every possible effort to co-operate with the various technical societies in other communities and unite with them by alliance wherever this is possible."

The following are abstracts of some of the papers presented:

Physical Tests of High Speed Steel

BY A. H. d'ARCAMBAL

Metallurgist, Pratt & Whitney Co., Hartford, Conn.

Transverse tests at room temperature and tensile tests at temperatures ranging from room temperature to 1,200 deg. F. were conducted on two types of high speed steel, namely, the 18 per cent tungsten, 1 per cent vanadium type; and the 14 per cent tungsten, 2 per cent vanadium grade. The specimens were given different hardening treatments, and after being tested, the fractures were examined, samples file tested, and micrographs made on samples given the various heat treatments.

The transverse tests showed that samples quenched from a high temperature and drawn to 1,100 deg. F. possessed the necessary hardness and gave a high fibre stress, showing almost double the strength of specimens quenched from the same temperature and not drawn. Quenching into a bath at 1,100 deg. F. and not drawing, gave about the same fibre stress and exactly the same microstructure as samples quenched into oil and not drawn. Several specimens in the undrawn condition could not be tested, due to the presence of grinding cracks caused by strains in the material.

Tensile test specimens, quenched from a high temperature, and drawn to 1,100 deg. F., showed the maximum tensile strength when pulled at 600 deg. F. Specimens quenched from the high temperature and not drawn, gave about 70 per cent of the tensile strength of samples quenched from the same temperature and drawn to 1,100 deg. F. before being tested at room temperature. Specimens given the high quenching treatment, but only drawn to 450 deg. F. possessed only a slightly higher tensile strength than specimens in the undrawn condition.

The higher vanadium type of steel gave lower transverse and tensile readings than the 18 per cent tungsten grade. This was due to some extent to the former type of steel not standing as high a quenching temperature as the higher tungsten type of steel, thus being slightly overheated, as shown by the fractures.

The Toughness of High Speed Steels as Affected by Their Heat Treatment

BY M. A. GROSSMAN

Metallurgist, Electric Alloy Steel Company, Youngstown, O.

Data are presented constituting the results of toughness tests on two high speed steels of common analysis. The tests were carried out on an impact machine of the Charpy type, on test bars which resembled the standard Charpy bar, unnotched.

A considerable number of test pieces were hardened and drawn, covering the quenching range from 1,700 to 2,250 deg. and the drawing range from no draw to 1,100 deg. For each quenching temperature a series of test pieces was drawn at all the drawing temperatures. It was found that there is a certain quenching temperature slightly below the proper hardening range for which the steel is brittle on being quenched and acquires no toughness on being drawn up to 1,100 deg. Below this quenching range, drawing imparts toughness but lowers the hardness. Above that range, drawing at 1,100 deg. imparts toughness while at the same time developing secondary hardness. The toughness tests and the hardness tests were carried out on the same test pieces.

Curves are given showing the changes in toughness for the different heat treatments and the change in scleroscope hardness for those heat treatments. The data show:

(1) That the development of secondary hardness in the proper hardening range is accompanied by an acquiring of toughness which may properly be called "secondary toughness," and

(2) that just below the proper hardening range there is a range of temperature which, while giving quite good hardness, results in the steel being brittle and remaining so even with subsequent drawing to 1,100 deg.

What Insulation Will Do for the Heat Treater

BY J. T. GOWER

Armstrong Cork & Insulation Co., Pittsburgh, Pa.

The benefits which are derived from the use of heat insulating materials can hardly be over-estimated. A few of the most prominent of these are:

(a) Insulation increases the capacity of equipment with no increase in fuel consumption.

(b) Insulation makes temperatures more uniform in heated equipment.

(c) Insulation decreases the time required to bring equipment to the working temperature.

(d) Insulation, in many cases, lengthens the life of refractories by eliminating the necessity for overheating in the combustion chamber.

(e) Insulation makes more comfortable working conditions by reducing air temperatures around the heated equipment.

The various factors governing heat losses through conduction are discussed and formulated mathematically.

Grinding Sparks as a Measure of Carbon Content

BY D. H. STACKS

Consulting Metallurgical Engineer.

The quality of iron and steel to produce sparks under certain conditions is acknowledged as ancient history. When a piece of iron or steel is pressed against a fast revolving grinding wheel, minute particles of metal are removed and thrown into space which are observed as Lines of Fire and which seem to become molten and finally disappear—in case of an almost carbonless iron—shaped like a steel needle with the point in the direction of flight and slightly tipped at the end on account of the rapid cooling effect of the atmosphere. In case the iron contains a small amount of carbon the needlelike effect is broken up with an explosion and little lines of fire dart out of what was originally the needlelike body. As the carbon increases, these secondary lines of fire again explode causing further subdivisions and the action continues as the carbon increases, until all that can be observed is a mass of explosions.

When steels contain alloys, such as nickel, chromium, vanadium, manganese, etc., the lines of fire and the spark explosions are more or less interrupted with less line of fire and smaller as well as larger explosions.

When all conditions are standardized, and by the use of known standards and with the personal equation eliminated, the inspection of steel can be successfully carried out by placing the unknown composition along with the known upon a specially designed automatic machine which will throw out two lines of fire and spark explosions simultaneously in such a manner that the carbon content of the unknown will be plainly observed for any commercial specification of steel commercially accurate.

Figures which represent over 100 determinations of open-hearth furnace checks and factory control work show that the average spark carbon results are identical with the combustion carbon, with the individual determinations checking on the average within 0.025 plus or minus and with but two extremes of 0.04 and 0.05 per cent of carbon variation from the standard combustion results.

The Electric Furnace as It Affects Overall Cost of Heat Treated Parts

BY C. L. IPSEN

Designing Engineer, General Electric Company, Schenectady, N.Y.

In the development of steel treating furnaces there has been a progressive change from one form of heat source to another, starting with wood and going on through coal, oil and gas, to electricity. Each change has been to a higher priced fuel, indicating that there are factors more important than fuel costs in steel treating. A table is given showing the over-all cost of several heat treated parts and the percentage of this cost that is chargeable to fuel. A small improvement in quality, reduction in rejections or saving in subsequent operations will in most cases cited many times offset the increased cost of improved heat source.

Electricity is the ideal heat source for steel treating because (1) the temperature of heat source is only slightly higher than parts being treated, so that no part can be overheated; (2) absolute temperature uniformity can be maintained; (3) the human element is reduced by the use of accurate and reliable temperature control.

In the selection of any furnace first consideration should be given to cost and quality of finished part, as it will in most cases show that the highest priced heat source is the least expensive.

The Efficacy of Annealing Overstrained Steel

BY I. H. CONDREY

Professor of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Steel is composed of granules of crystalline material inclosed in thin envelopes of non-crystalline or "Amorphous cement." This "amorphous cement" is hard and strong but brittle, and tends to impart properties to the metal in proportion to the quantity present.

During overstrain motion occurs between adjacent portions of the granules, which results in the transformation of some of the originally crystalline metal into the amorphous state. Hence, overstrained steel becomes harder and more brittle, hence less resistant to shock. These are undesirable properties. It is customary to anneal many steel parts periodically.

Tests have been made to prove the efficacy of such treatment and the results lead to the following conclusions:

1. Overstrain of metal when its temperature is below the transformation range results in the production of undesirable properties tending to render the metal unfitted to withstand sudden and shock loads.
2. If possible such effects should be eliminated for the safety of those using devices which have been so abused.
3. Proper annealing suffices to completely restore the normal properties of low carbon steel even after the most severe overstrain.

The Heat Treatment of Copper and Brass

BY F. H. HELRIGEL

Metallurgist, Motor Products Company, Detroit, Mich.

The heat treatment of copper and brass, like the training of a child, begins before it is born. There are certain elements introduced into the metals from the ores which no amount of commercial refining will eliminate and which almost entirely govern the quality and use to which the metals can be put.

Copper occurs as pure metal, and as sulphide or carbonate. It is first roasted and then reduced to metal, much as iron is reduced in the blast furnace and later converted to steel in the open hearth. Very few impurities are present in copper. Zinc occurs as sulphide and carbonate and is reduced by distillation. It is from zinc that most of the impurities of brass are obtained; bismuth, arsenic, cadmium, iron, lead and tin occurring most often.

Brass is manufactured by melting up copper in crucibles or furnaces, adding to it scrap brass and zinc and pouring, either into castings or into forms for further working. Every quality that a brass casting must possess is imparted to it by its chemical composition. It cannot be heat treated. Brass that is to be used for sheets, strips, tubing, etc., is further rolled, annealed, pickled and the process repeated until reduced to size.

One might state as final and conclusive that there is no such thing as heat treatment of copper and brass, that it can only be annealed, and if the metals were pure and annealing conditions ideal that would be so. However, foreign elements in brass, intentional or otherwise, almost govern its treatment. Iron and lead are to brass what phosphorus and sulphur are to steel, as to machining qualities, hardness and tensile strength. Manganese plays much the same role in each. Brass annealed dead soft, containing tin or iron, has a much higher tensile strength and hardness than pure brass. Other factors governing the annealing are degree of hardness, due to cold working, time and temperature. While the annealing of brass is a simple straightforward proposition, it requires a sympathetic understanding of what ails the metal to treat it accordingly.

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Idle Locomotives—Built in England for War Service in France—Too Heavy for Service in England

The Effect of Temperature in Case-Hardening[*]

A Discussion of the Relation of Temperature to Quality of Case and Core in the Carbonizing Process

BY THEODORE G. SELLECK

IN discussing this subject it is important that we have a clear idea, first of all, as to what is meant by the terms "case" and "core" of carbonized steel, and what their physical and chemical characteristics are.

In all carbonizing operations there is or should be left a portion of the metal in its original condition; that is, a part of the metal is not allowed to carbonize, being prevented from so doing by the shortening of the carbonizing period; hence the steel in that section remains or should remain in the condition it was in before the operation began. Such section of the metal is called the "core," while the carbonized and hardened surface is called the "case."

The low carbon core of case-hardened steel imparts the ductility necessary to resist breaking strains, while the case furnishes a hard surface for resistance to wear, this combination furnishing parts that combine those two important qualities as no high carbon steel could, and at the same time permitting rapid and easy machining. This fact, of economical machining of parts out of soft material, is the real reason for the high importance case-hardening has attained as a manufacturing process.

Proper Heat Treatment Absolutely Essential

The temperatures at which the steel is carbonized, and heat treated, have a marked effect upon the physical qualities of both the case and core since the operation of carbonizing, under the most favorable conditions, always leaves the metal in a condition of almost absolute ruin, if no heat treatment were to follow the carbonizing. All carbonized steel before receiving heat treatment is brittle and also very soft, and its physical qualities are not as high as a poor grade of gray iron. The structure is coarsely crystalline throughout, with no definite division between the core and case and the whole structure seems to be lacking in cohesion, suggesting to the eye something that is just ready to fall apart of its own volition. A microscope reveals only a slight difference in the conditions visible to the unaided eye and shows that the structure of the case is a bit closer and somewhat finer grained. The lack of cohesion, however, is more pronounced when observed under the glass.

In order to make this metal of any value, it becomes necessary to subject it to heat treatment. If the highest quality is desired in the structure of the core, the heat treatment must be at such a temperature, and of such a nature as will place it in the condition found before the operation of carbonizing disturbed its structure. This means that the metal must be heated slightly beyond its critical temperature and quenched. If the highest quality is desired in the case also, the same treatment must be repeated for the higher carbon case.

It is sometimes the practice of casehardeners to quench steel directly from the pot at temperatures very close to the carbonizing temperature. While this sometimes is practiced without any serious results, it is bad practice and parts so treated never possess anything approximating the quality possible were they handled properly. Other casehardeners allow the parts to cool slowly in the pots and reheat for a single quench. In such cases, great economy is sometimes effected if the loss of parts through failure to pass final tests does not absorb all the saving of an extra quench.

Quenching from the pot may result in serious losses, as will be seen in following paragraphs, and the single quench treatment may bring such a variety of troubles that it would take too much space to enumerate them; but if it must be done, the operator should know first, whether the core or the case is most essential to the value of the part; second, he should know approximately at least, the carbon content of both the case and the core; and his treatment should be based upon one or the other for there is no one temperature which can give maximum quality to both. In some cases it is a matter of getting pieces hard without reference to any special quality that the work must show, and in such cases it is of little use to give advice; but to the casehardener who has quality of work in his mind the writer suggests that he always make sure of every point, especially in the heat treatment of carbonized parts, for as shown, carbonizing itself absolutely ruins the structure of steel. Thus it is up to the steel treater to redeem it.

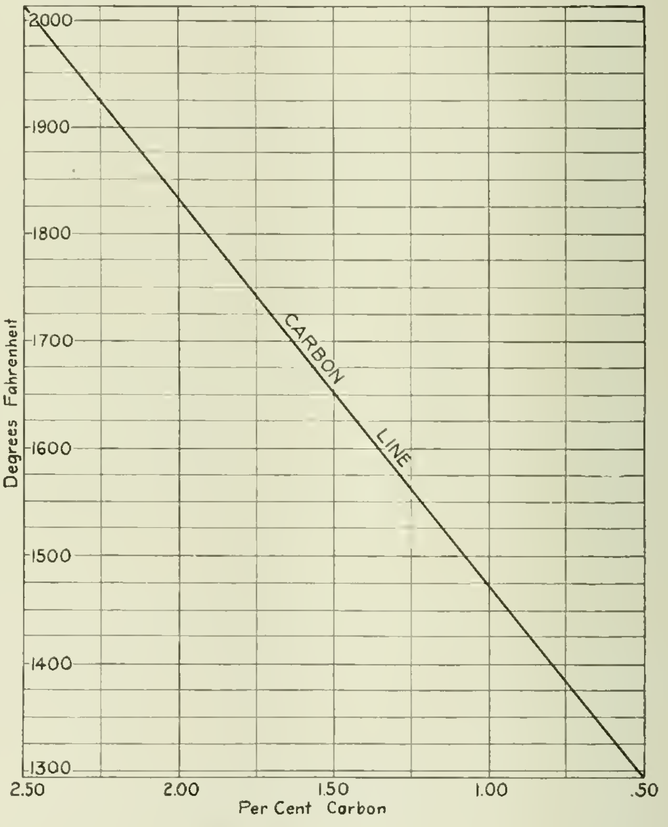

Fig. 1—Relation of Temperature to Carbon Content of Carbonized Case

The effects of high temperatures, both in carbonizing and in heat-treating, are more marked in the quality of the case than in that of the core, because the core is always the same steel after carbonizing that it was before, and has the same critical point. The case, however, has assumed a different chemical constitution, different physical qualities, and has become a complex steel, instead of a simple, homogeneous metal that it was in the beginning. It requires a more exact knowledge of the constitution and physical qualities of the

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[*] Abstracted with permission from the August transactions of the American Society for Steel Treating.

steel in order to determine the treatment it should have for its highest refinement.

Carbonized steel has often been referred to as a "double steel," because of the two zones of "low carbon" and "high carbon" set up in the carbonizing of the metal but it is more complex than a simple double steel, if we consider the conditions found in the chemical make-up of the case and the various physical conditions that are established in the application of heat thereto during the carbonizing as well as the heat treating operations.

It will be well to consider here something of the manner in which the case is made up and its true relation to the core. The carburization of steel is produced by the introduction of carbon into the metal from the surface toward the core. During this introduction of carbon that element is always more abundant at the extreme surface than it is at any point between the surface and the uncarbonized core; in other words, there is a gradual lessening of carbon content between surface and core, and no abrupt line of division between them. The percentage of carbon that will be present in the surface of the case depends most largely upon the carbonizing temperature to which the steel was subjected and partly, to the manner and nature of the heat treatment given it subsequent to carbonizing.

Relation of Temperature to Carbon Content

The chart, illustrated in Fig. 1 shows the relative amount of carbon that steel will absorb when carbonized at various temperatures. This chart is based upon the researches of David Flather, who in 1903 in a technical journal, stated that: "Iron, saturated with carbon at 700 deg. C. can contain only 0.50 per cent carbon; at 900 deg. C., 1.5 per cent carbon; at 1,100 deg. C., 2.50 per cent carbon." These values are given as for the saturation of the iron in the metal; that is, the iron at those temperatures can contain the percentage of carbon indicated. In the application of the carbonizing process the fact should be remembered that there is always a saturation of the metal on the extreme surface and that saturation is maintained as long as the temperature is maintained. From that saturated portion of the metal the carbon diffuses into the metal just as water will diffuse into wood when the surface of the wood has become saturated with it. In like manner does the carbon find its way into steel; and the saturation gives way to gradual diminution of carbon content as it approaches the core.

The chart in Fig. 1 is more easily understood by considering the theory that all carbon is dissolved at the surface of the steel in all carbonizing operations, and is not deposited from gases entering the metal.

Some of the phenomena observed in the manipulation of the process seem to point to some such condition existing at the surface of the metal, for if we take a piece of carbonized, low carbon steel from the carbonizing pot while it is at a carbonizing temperature, and quench it quickly enough to avoid any possible chance of the carbon burning out of the metal when it comes into contact with the air, and have the quenching medium a very fast one, such as brine or ice water, we find a concentration of carbon at the extreme surface greater than ever experienced in the cooling of the steel in the carbonizing mixture and reheating, or even in the ordinary quenching direct from the pots. The carbon is there as a solid solution which has not had an opportunity to diffuse into the metal, and it is always there in a percentage equal to the saturation point of the metal.

This saturation and diffusion of carbon is responsible for the great complexity of the case referred to; it establishes in the carbonized portion or case what are recognized as three zones of varying carburization. These are shown according to their carbon content as the hypo-eutectoid, eutectoid, and hyper-eutectoid. The first of these zones, hypo-eutectoid, is that containing the lowest percentage of carbon, and lies next to the core; its carbon content is under 0.87 per cent; the next, or eutectoid zone, is that portion of the case lying next to the hypo-eutectoid, and contains 0.90 to 0.95 per cent carbon; while the hyper-eutectoid contains above 0.95 per cent of carbon. Thus carbonization at temperatures above 900 deg. C. (1562 deg. F.) is quite sure to give a hyper-eutectoid case, and lesser temperatures may provide a case of most any desired carbon content.

In practice it would be difficult to establish an exact schedule of temperatures for the various requirements in carbon content but if we carbonize at a certain temperature, for a certain depth at least, the case will have the amount of carbon the chart indicates. Such depth is sometimes so slight as to make it difficult to get a chemical analysis, but photomicrographs often prove such values in quite a convincing manner.

After steel has been carbonized its heat treatment must be governed by the nature of the service that it will be obliged to render. If a hyper-eutectoid case has been established and the requirement is for extreme hardness without the need of any particular toughness in the sharp edges or the lighter sections of the material, the quench for the case should be at the critical temperature of approximately 1.00 per cent carbon steel, without any subsequent draw; but if the wear to which the parts are to be subjected is abrasive in character such as gears, or dies, the parts should be given a draw of approximately 400 deg. F.; the exact temperature of the draw can only be determined when the scleroscope or Brinell hardness requirement is known. It is a matter usually for the operator himself to determine by test, since there are always variations in steel, and in conditions within the shop that make it impossible to establish exact rules for hardening steel that may be followed successfully by all steel treaters.

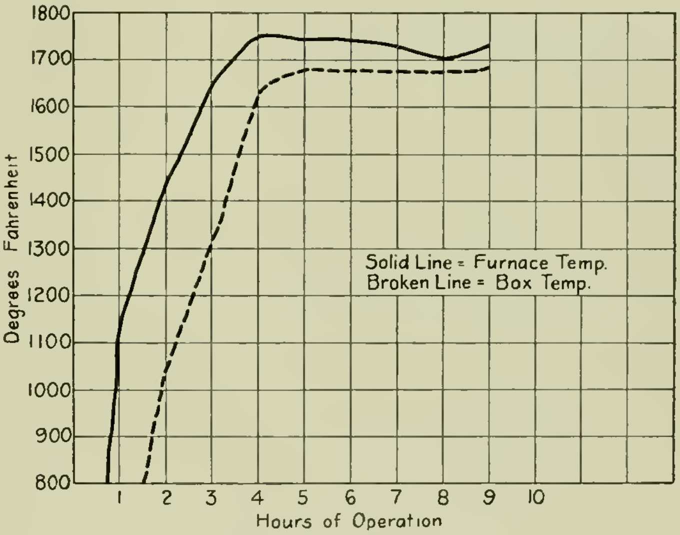


Fig. 2—Curves Showing Comparative Temperatures Inside and Outside of Boxes During Carbonizing Operations

A single quench for carbonized parts always should be avoided where it is economically possible, and never should be chanced where the carbonizing temperature exceeds 1,650 deg. F. (if quenching from the pot is necessary) for such practice results so often in the absolute loss of parts so treated, that the chance of avoiding trouble is too small to be worth considering.

Temperatures of Furnace and Carbonizing Boxes

A chart is shown in Fig. 2 giving the comparative temperatures inside and outside of carbonizing boxes during carbonizing operations; these are composite curves made from a long series of tests. This chart shows that under regular conditions the inside of carbonizing boxes is at a much lower temperature than that of the furnace.

There are conditions, however, when an excessive temperature is established inside of carbonizing boxes, and will increase there even after the temperature of the furnace has been lowered. One such test is shown in Fig. 3. In this case it will be noticed that the temperature inside of the box was higher than that of the furnace chamber for a period of more than 3½ hours, and while the furnace temperature was falling rapidly, the box temperature was rising almost as rapidly. The cause of this condition was a very combustible carburizer made chiefly from coal products containing oil and other hydrocarbons, which produced gas at very low temperatures and at such velocity that the sealing of the box was of no use. Fig. 4 shows the result of another test of the same character, in which the trouble was not caused by the carburizer but by an imperfect box. In this case a small blow hole in the cast-iron box permitted the entrance of enough oxygen to stimulate the combustion of the organic matter of which the carburizer was composed. However, in the composite curve (Fig. 2) all of these various conditions are represented in the average indicated.

The writer does not wish it understood that he considers this composite curve a fair average of the conditions obtaining in general practice of the carbonizing process, for these tests were made under conditions which perhaps would not be considered the average, and under the best modern shop conditions a better result than this should be shown by similar tests. The author believes that in the average case-hardening plant the operator is very much off in his estimate of the time required to bring carbonizing boxes to the temperature of the furnace, as indicated by his pyrometer, especially when little care is shown in the proper placing of the thermocouple. If some operators would take the pains to check up on themselves, they would meet some surprises. In these charts it will be noticed that the variation of temperature between the inside and outside of the boxes was very pronounced, sometimes for several hours, and the composite curve shows that as an average, there was a difference between the two temperatures of about 125 deg. after 4 hours of heat.

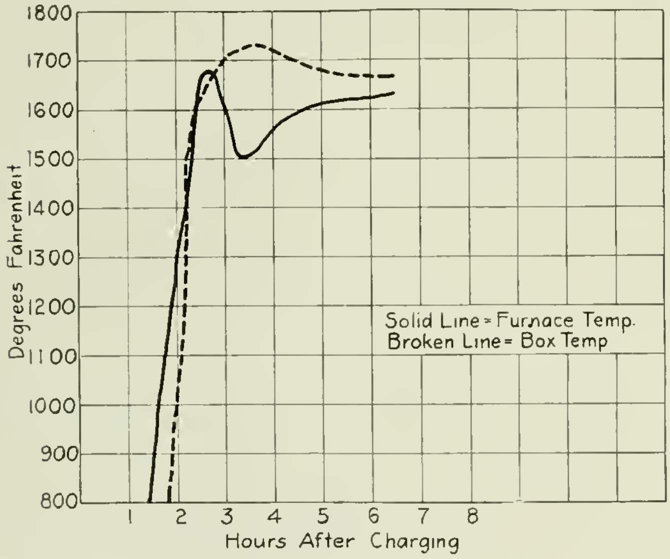


Fig. 3—Curves Showing Excessive Temperature Established Inside Carbonizing Boxes After Furnace Temperature Has Been Lowered

The boxes used in these tests were of standard size, of the following inside measurements: 4 in. wide, 6 in. deep and 18 in. long. Various kinds of carburizers were used to determine the comparative heat conductivity of the various compounds.

The relation of temperature to the quality of case and core is a very direct one, as indicated by the straight carbon line shown in the chart in Fig. 1. This is for the carbon content of the case and should indicate to the operator the heat treatment of the case. In Fig. 5 is shown the quenching temperatures of steels of various carbon content, which will be useful to the operator who desires knowledge of the proper temperature for the refinement of the core or case. This chart does not take into consideration the presence of any alloying elements in the metal.

No Hard and Fast Rule for Heat Treatment

There are no hard and fast rules for the treatment of carbonized steel, beyond that of the strict observance of the critical temperatures of the metal. This is at times difficult to determine without scientific apparatus for the purpose, and the average case-hardener can not avail himself of the use of those important and expensive instruments; so it becomes necessary for him to use common-sense, and proceed slowly in all his operations until they are demonstrated to be right. Where a critical point is in question, and no equipment for determining it is at hand, practical tests should be made until the fracture of the metal indicates the proper temperature. It is always better to sacrifice a few parts for the establishing of proper heat treatment than it is to go ahead blindly and perhaps sacrifice hundreds of valuable pieces later on.

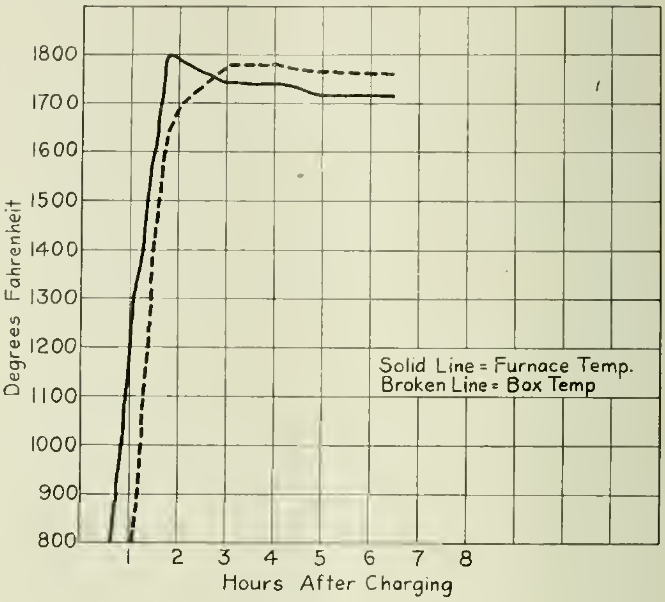


Fig. 4—Curves Showing Temperatures Inside and Outside of Carbonizing Box, the Box Being Imperfect

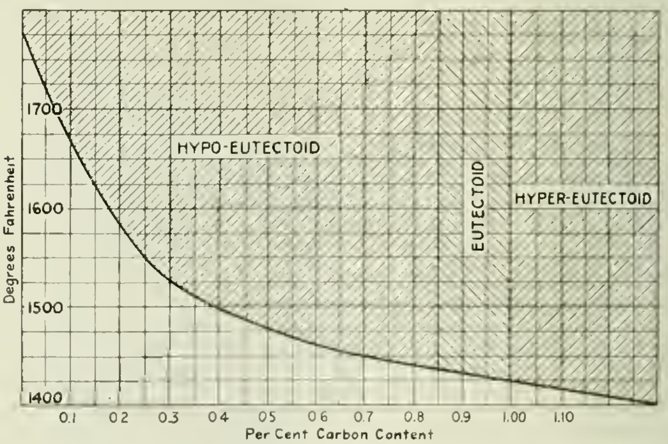


Fig. 5—Quenching Temperatures of Steels of Various Carbon Content

Wheel Lathe Tool-Holders for Use With High-Speed Steel Tool Bits

THE day of the solid high-speed steel tool for wheel lathes has passed, owing to the excessive cost of the steel, difficulty in handling heavy tools and loss due to breakage. Several forms of tool-holders have been developed from time to time, using high-speed steel tool bits and thereby obtaining maximum service from the high-speed steel. Among these tool-holders, the two illustrated have been developed on a large eastern railroad and demonstrated their value by more than two years' continuous service. These tool-holders have several advantages over some of the other kinds developed. In the first place, the tool bits are solid pieces of high-speed steel made without holes. This is an important feature for two reasons: each tool bit can be readily heat treated with less danger of breaking than if it was drilled for a clamping bolt; in addition, when the tool bit is worn down as far as practicable in the tool-holder, it can be drawn out into smaller tool bits and thus entirely used up. This would be impossible had the tool bit been drilled.

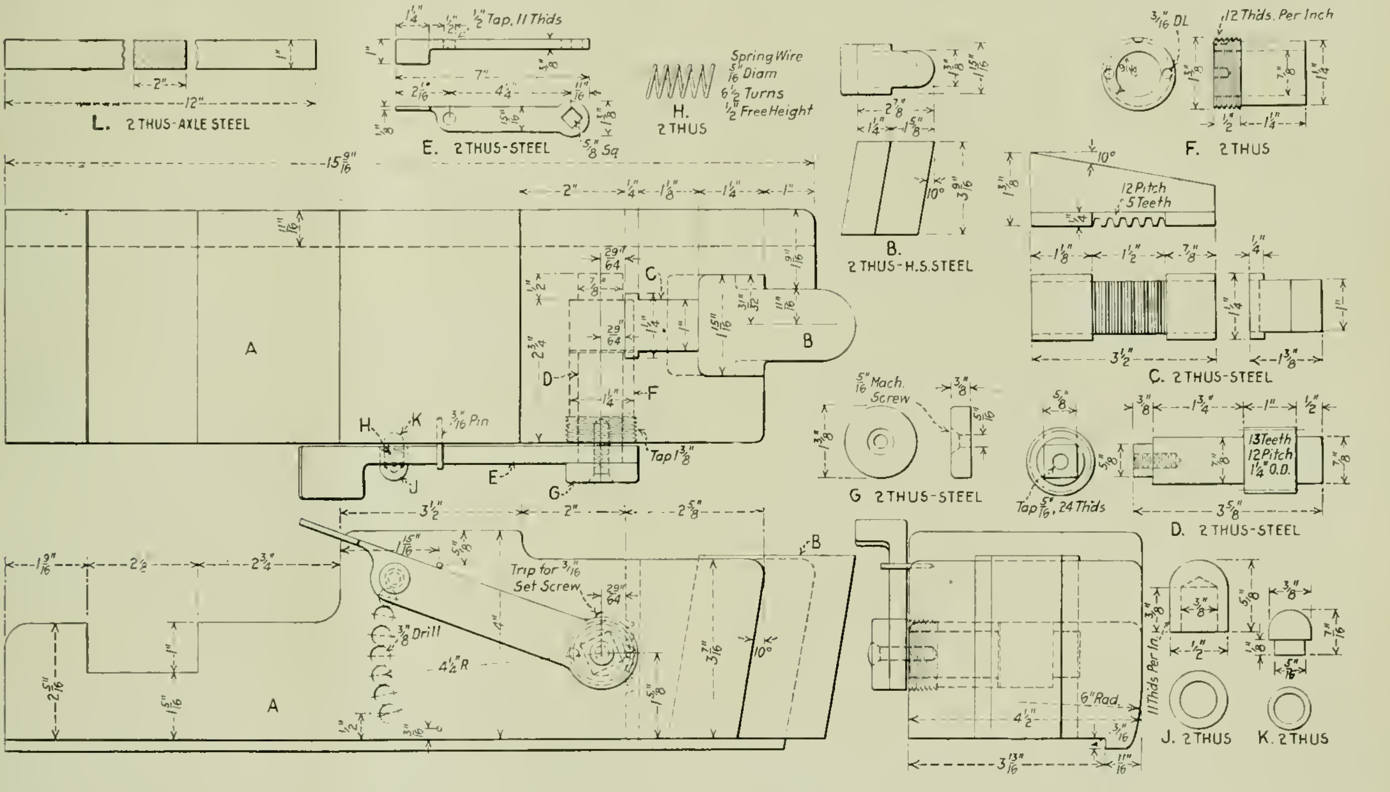


Fig. 1—General Arrangement and Details of Left-Hand Wheel Lathe Roughing Tool Holder

In common with other tool-holders, the two illustrated have the important advantage of greatly facilitating grinding. It is true that the roughing out of wheel lathe tools is commonly done in the toolroom on some form of tool grinding machine, but very often it is necessary for the wheel lathe operator to touch up the top surface of the tool at the cutting edge in order to secure the best results. It is something of an effort to carry a solid lathe tool 18 in. long, made of 1½ in. by 3 in. stock, to the grinding wheel and back again, to say nothing of manipulating it during the grinding operation. Moreover, unless two trips are made, both the right and left hand tool must be carried at the same time. As one lathe operator with many years' experience said, "These tool-holders are great time and labor savers. I get more work out of the machine and at less effort on my part by keeping the tool bits in first-class cutting condition. There are no more heavy tools to carry around and it is not even necessary to loosen and retighten clamping bolts when removing the tool bits for grinding. They are readily released from the tool-holders without touching the clamping bolts and are just as easily replaced."

Holder for Round Nose Roughing Tool

Reference to Fig. 1 will show the general arrangement and details of the tool-holder and tool bit used in taking roughing cuts. This tool-holder is made of hammered axle steel in two styles, right and left, the details shown being for the left-hand holder. The body of the holder *A* is slotted at the right-hand end to receive tool bit *B*, which is shaped as indicated and carefully heat treated to stand up under the heaviest cuts. The tool bit is backed by a tapered wedge *C*, having teeth cut on the back as shown in the detailed view. Wedge *C* can be operated up and down for loosening or tightening the tool bit by means of a pinion on shaft *D* revolved by lever *E*. One end of *D* is supported by a bearing in *A* and the other end by sleeve *F*. The lateral play of *D* is also adjusted by sleeve *F*. Lever *E* fits on the squared end of *D* and is held in place by means of a small washer *G* and a 5/16-in. machine screw. Parts *J*, *H* and *K* provide a spring button to enter the radial drilled holes in *A* and hold the lever in whatever position is desired. Stop pins, 3/16 in. in diameter, limit the swing of lever *E* as shown.

Should the tool post clamping bolts be insufficient to prevent the tool-holders from slipping back under heavy cuts, crossbar *L* is provided and can be inserted in the 2⅛-in. by 1-in. slot in body *A*. With this crossbar held against suitable stops by auxiliary clamps, the tool-holder can be held rigidly under the heaviest cuts.

Holder for Finishing Tools

The general arrangement and details of a device for holding forming or finishing tool bits are shown in Fig. 2 and only one style of holder is required for both right and left-hand tool bits. As in the previous case, the body *1* is made of hammered axle steel to the shape shown with one jaw indicated at *a*. Part *2*, shown in heavier lines, is a machined forging composed of jaw *b*, a circular body and a lever arm drilled and tapped for a 1⅛-in. set screw *3*. This set screw extends through a 1¾-in. hole in body *1* and bottoms on the opposite side of the 2-in. slot shown. Tightening set screw *3* by means of a socket wrench will bring jaws *a* and *b* together and exert heavy pressure on forming tool *4*. Loosening the set screw will enable the forming tool to be quickly and easily removed. Forming tool *4* is provided for finishing the flange and part of the tread, tool *5* forming the remainder of the tread and the chamfer. In handling the tool-holder part *2* is prevented from falling out of body *1* by means of strap *6* held by two 5/16-in. fillister head screws *7*. This arrangement is plainly shown in the drawing. To facilitate machining part *2* a 15/16-in. hole is drilled as shown and this hole is later filled by driving in plug *8*. As in the previous case, the 2½-in. by 1 3/16-in. slotted hole in body *1* is intended to provide auxiliary means for clamping the tool in place.

The construction of these tool-holders is such as to hold the tool bits and forming tools with great firmness under heavy cuts, at the same time permitting their ready removal for changing or grinding. When the tool bits are new, they rest on the bottom against the wheel lathe tool post, but as they become worn down by grinding, filler blocks are inserted to keep the cutting edges at the required height. Reference to Fig. 3 shows the actual appearance of two tool-holders which have just been removed from the lathe. Several tool bits, filling blocks and forming tools used with the holders also are shown.

Fig. 3—Tool Holders, Tool Bits and Filling Blocks

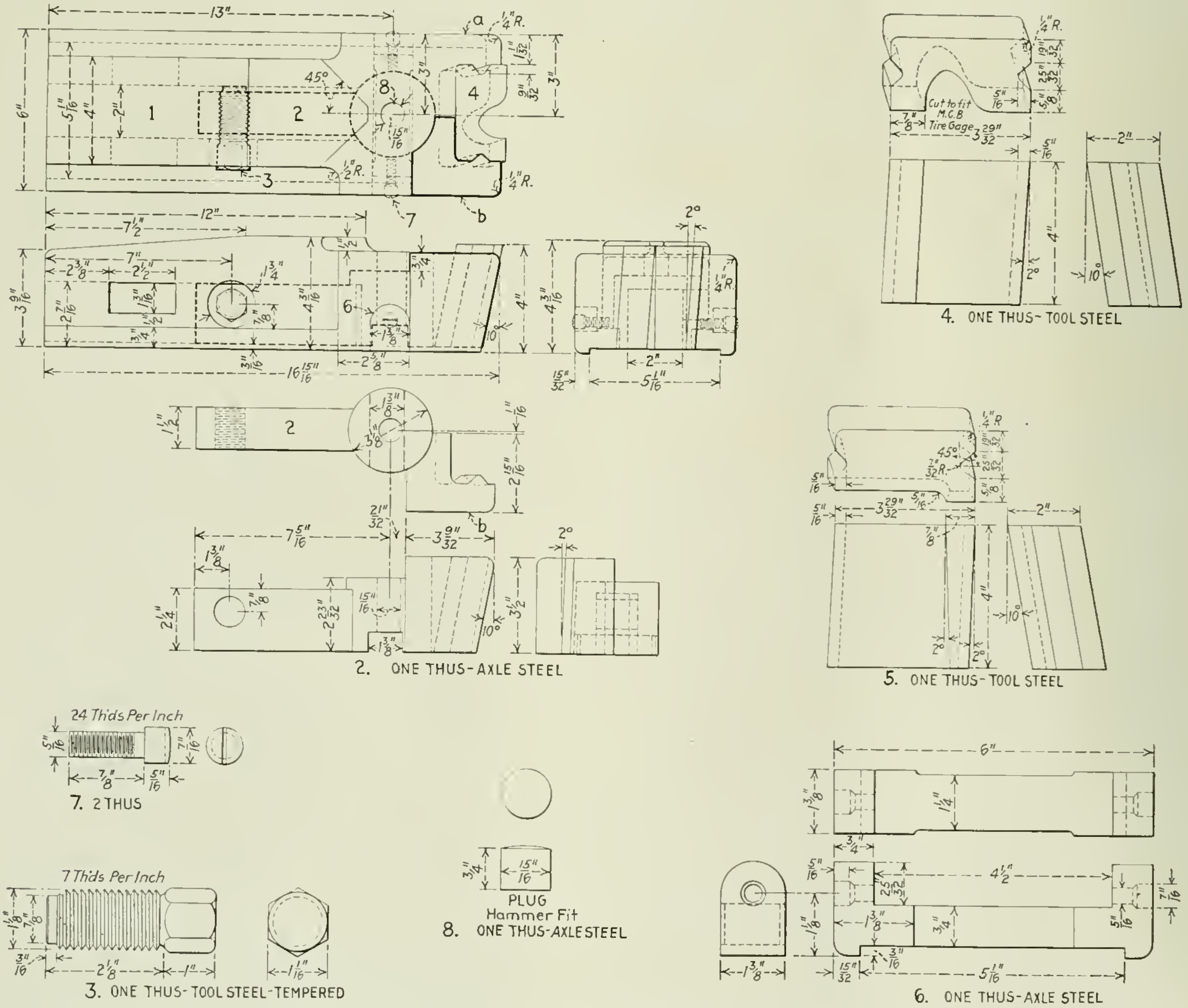
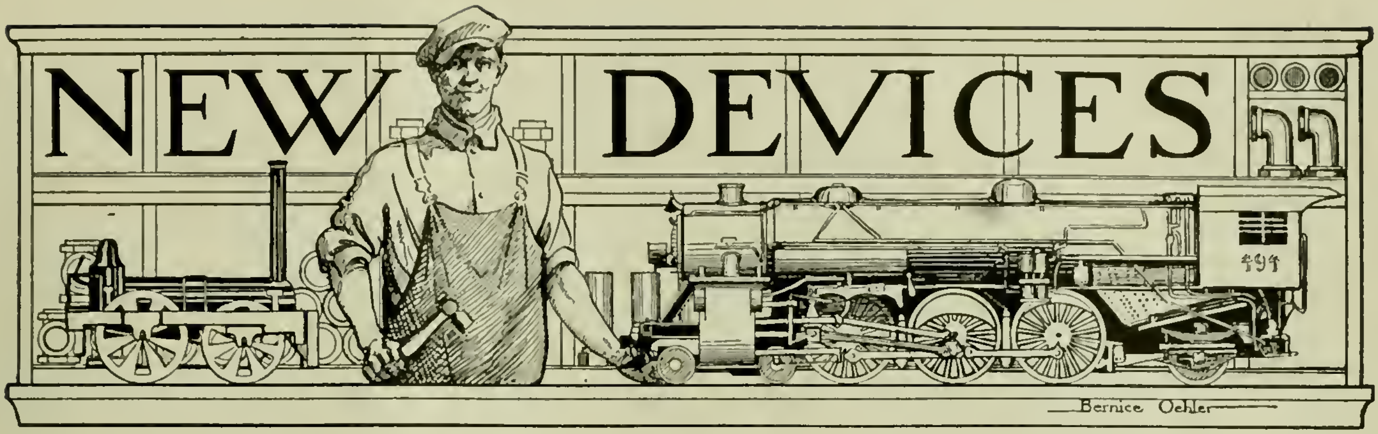
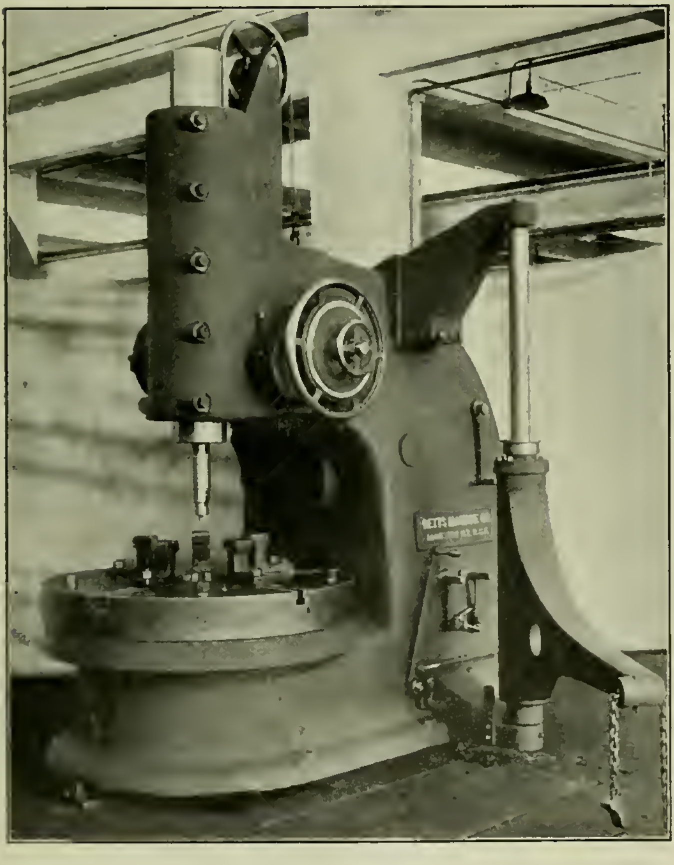


Fig. 2—Forming and Finishing Tool Holder, Made in One Style Only



Heavy Car Wheel Boring Machine

THE latest addition to the line of heavy railroad tools made by the Betts Machine Company, Rochester, N. Y., is a heavy duty, 52-in. car wheel boring and facing machine, illustrated. This machine is designed and constructed so as to cover the range of requirements of both manufacturing and repair shops, for car building and railway repair shop work, and is a rapid production machine for manufacturing purposes.


Betts 52-In. Car Wheel Boring and Facing Machine

The bed and frame is one massive casting which is exceptionally rigid and the machine is designed to meet sucessfully the stresses of modern high production. While the design is massive and the construction heavy, special attention was given to extreme simplicity as well as ease of operation which in turn reflects itself in increased output.

The machine is furnished to be driven either through a single pulley, or direct connected to a constant speed or variable speed motor. The necessary speed changes to give face plate revolutions of 10.2, 13.9, 20.4 and 30.7 per minute, are obtained by means of hardened sliding steel gears, running in oil. The two short levers shown on the photograph are used for obtaining the four speed changes and they are interlocked in such a way that no two sets of gears can be in mesh at the same time.

The table is proportionately heavy, revolves on a wide bearing and has an extra large spindle running in bronze bushed bearing. The spindle is provided with a locking collar at the lower end to prevent lifting and great care has been taken to insure proper and adequate lubrication for all revolving parts.

The table is equipped with a five-jaw chuck, built in and a part of the table. This chuck is both universal and independent, and readily adjustable for wheels of any size within the range of the machine. Five stations are provided for operating this chuck, so that one of them will be convenient to the operator regardless of where he stops the table. The long lever shown just at the right of the table is used for operating the friction clutch and brake, whereby the operator can start and stop the machine in the minimum time.

The boring ram is of large diameter, with an exceptionally long bearing in the frame. The six automatic boring and facing feeds are obtained by means of a two-step cone and triple hardened sliding steel gears, so arranged that change from roughing to finishing can be made instantly. The boring ram has an easy hand adjustment which is facilitated by a counterweight contained within the machine.

When so desired, this machine can be equipped with a facing ram which, however, does not show in the photograph. This ram is so constructed that the facing head is supported close to the cut, enabling much heavier cuts to be taken. Also it is so constructed that it can be slid back entirely out of the way when chucking the largest diameter wheels.

The machine is regularly equipped with a quick-acting, powerful, pneumatic crane for handling the wheels in and out of the machine. This crane can be furnished to operate by individual motor or belt if so desired.

A strong feature of this new design is the ease of control by the workman. Every lever, including the starting and stopping lever and the speed changing levers as well as the devices for changing feeds and the hand adjustment of the boring ram are within easy reach by the operator from one position and the friction clutch and brake provides a simple control that is most effective.

An Alloy for High Temperature Castings

THERMALLOY is a high chromium alloy said to remain unchanged under drastic thermal conditions. It is not affected at elevated temperatures by oxidizing or reducing conditions nor will it absorb carbon or other injurious substances.

Strength and freedom from internal changes and transformations under alternate heating and cooling are characteristics claimed for Thermalloy. These characteristics prevent bending, warping and cracking, so that containers made of this material retain their original form at high temperatures encountered in heat-treating operations. Tests have shown that the alloy will serve for several thousand hours at 1800 deg. F. and will give considerable life at 2300 deg. F. in intermittent service.

Castings made from Thermalloy are uniform and free from blow-holes or segregations and can be made from 1/16 in. up to any desired thickness and from an ounce or less in weight up to several thousand pounds. The alloy is easily welded or machined for special requirements.

Physical Properties

Melting point		2,760 deg. F.
Specific gravity		7.60
Weight per cu. in.		0.27 lb.
Coefficient of expansion, per deg. F		0.0000088
Brinell hardness (1,000 kg.) (special grade, file hard)		130-200
	Cast	Forged
Ultimate strength	60,000	120,000
Elastic limit	50,000	75,000
Elongation (2 in.)	1.5%	10%
Reduction of area	2.5%	15%

Curves showing the loss in weight by scaling of various metals are shown in Fig. 1 Test pieces of the indicated materials were obtained in the open maket and after a careful determination of weight and surface area these were heated in a gas-fired furnace with excess air. At four-hour intervals the samples were removed, cooled, hammered free from scale and then replaced in the furnace. At the end of each test period the total loss in weight was accurately determined and the loss per unit area calculated. This test was repeated at each of the temperatures indicated and the results so obtained are shown graphically in Fig. 1. The test shows that Thermalloy was entirely unoxidized below 2150 deg. F. and above this temperature more slowly affected than any other base metal at present available.

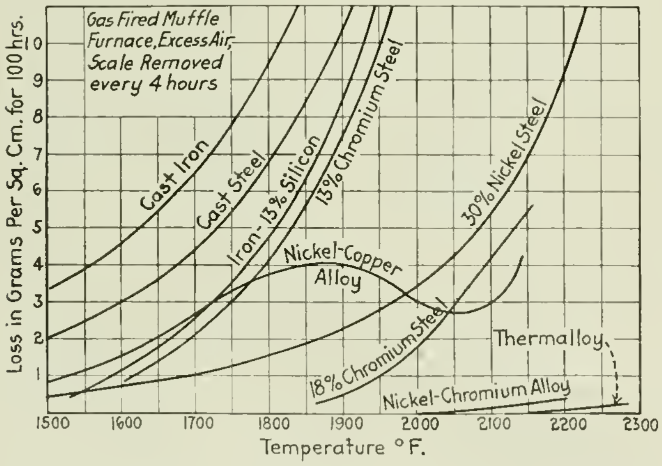


Fig. 1—Curves Representing Rate of Oxidation (Loss in Weight by Scaling) In Grams per Sq. Cm. per 100 Hr.

Next to oxidation heating efficiency is the most important quality of any material used for heat-treating work. Fig. 2 shows graphically the results obtained in a series of heat conductivity tests. Three new closed-end tubes exactly alike in dimensions—one of Thermalloy, one of steel and one of cast iron were placed cold in a furnace preheated to 2000 deg. F. Each tube contained a thermocouple which was mounted alike in all three. Temperature readings taken at ten-second intervals gave figures from which the curves A, B and C were drawn. These show that Thermalloy heats through more rapidly than new, unoxidized steel or cast iron.

The same three tubes were then heated to 1750 deg. F. for 100 hr. and the above test repeated with results shown by curves A (Thermalloy unchanged), B' and C.' The interior of these three tubes reached 1500 deg. F. in 2⅓ min., 3½ min., 4⅓ min., respectively. Five minutes after placing in the furnace the interior of the Thermalloy container had reached 1975 deg. F. while steel showed but 950 deg. F. and cast iron only 850 deg. F., an advantage of more than two to one.

The Thermalloy tube was later maintained for 500 hr. at 1800 deg. F. and the above test repeated on this tube alone with identical results (the steel and cast-iron tubes were completely destroyed in less than 250 hr.) showing that the heating efficiency of Thermalloy is not affected by continued service.

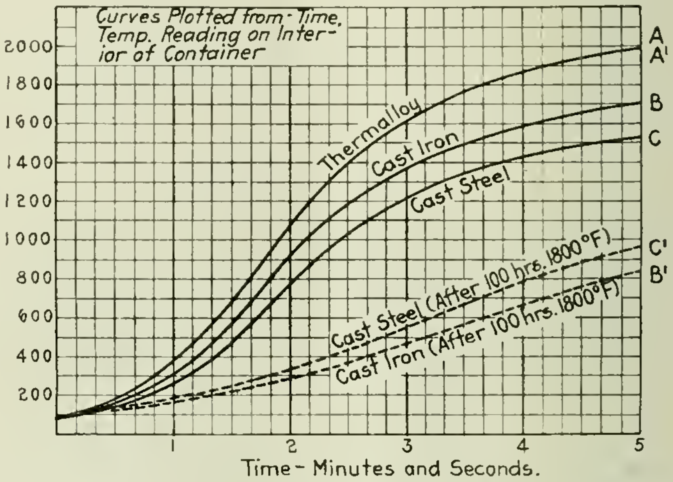


Fig. 2—Curves Showing Comparative Heating Efficiency of Thermalloy, Steel and Cast Iron and the Effect of Scale Formation on Heat Retardation

The rate at which heat is transmitted to the interior of a metallic container depends primarily upon (1) wall thickness, (2) thermal conductivity of the metal, and (3) the condition of both inner and outer surfaces. Of these three factors surface condition is in this case by far the most important. As an example, cast iron or steel conducts heat over one hundred times more rapidly than does the oxide scale which forms on the surface of these same metals when heated, so that only 1/100 in. of scale will retard more heat than an additional whole inch thickness of scale-free metal. Also, a variation in this scale thickness from heat to heat will prevent uniformity of results.

Iron or steel boxes last only a few hundred hours, which means frequent replacements and often serious loss of valuable material, and this, together with increased fuel consumption and reduced furnace capacity due to greater weight and bulk and heavy scale, is often more expensive than the initial cost of a complete Thermalloy installation. Thermalloy is recommended for the following and similar high-temperature equipment: carbonizing containers, annealing boxes, lead, cyanide and salt pots, furnace grates, rails, doors and automatic stoker parts. Thermalloy is manufactured under Fahrenwald Patents (issued and pending) exclusively by the Electro Alloys Company, Cleveland, Ohio.

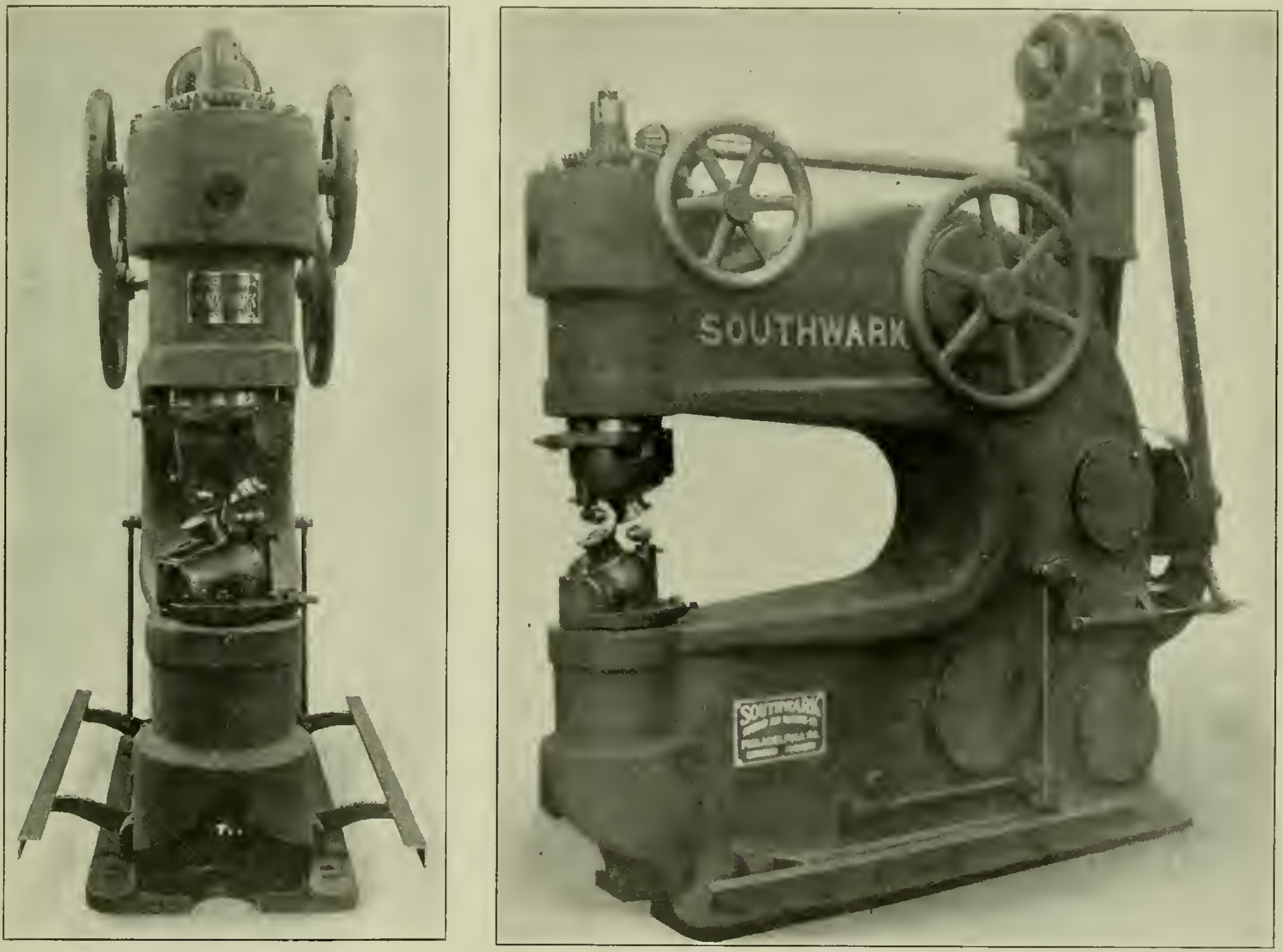
Rotary Turret Shear of Large Capacity

THE Southwark Foundry & Machine Company of Philadelphia, Pa., has recently developed a rotary shear, known as the No. 3 Southwark-Gray double turret rotary shear, which is capable of cutting plate up to 3/8 in. in thickness and is therefore of a considerably larger capacity than the No. 0, No. 1 or No. 2 machines which were brought out a year ago. The No. 3 machine has a throat depth of 30 in. and is driven by a 3 hp. motor. The sizes and character of the work which can be done on this machine should make it a valuable tool for railroad shops.

Because the cutters, while working, can be changed to any degree of a circle, this machine shears various shapes without turning the sheet or plate during the cut. It cuts any conceivable shapes or openings with minimum radii equal to the radius of the cutters, in stock not heavier than one-half the capacity of the shear. On heavier stock up to the capacity of the machine the minimum radii will be slightly larger than the radius of the cutters. The cutters on this shear are smaller than on other rotary shears.

This shear cuts any shaped openings up to double the throat depth at any distance from the end of sheets or plates, regardless of length. Cuts as wide as the throat depth are made in a continuous operation. Greater widths up to double the throat depth are cut by first shearing in as far as possible from one edge. The sheet or plate is then given a half turn or is turned over and the balance of the cut is made from the opposite edge. The rotary shear cuts a straight line faster than any other tool except the gate shear, which makes the entire cut at one stroke.

The line to be cut is accurately followed by means of the turret, which is revolved by the guide wheel, the course of the cutters being changed to follow the line. On large sheets or plates, in making simple cuts, such as angles of any kind, the work can be done more quickly and easily by throwing the cutters in line with the cut to be made than by moving the stock in line with the cutters. When the position of the cutters is changed the direction of the feed is correspondingly changed. The cutters automatically feed the stock through the shear. The machine can be operated from either side so that the operator's vision of the cutting line is never obstructed. When preferred the sheet or plate can be guided by hand, the same as on the old type shear.



No. 3—Double Turret Rotary Shear—Both Turrets are Revolved Together so That Cutters Always Maintain the Same Relative Position

It is never necessary to disengage the power and use hand power for small radii. The cutting of zigzag lines and small radii under power without speed changing gears is made possible by the sensitive clutch, by means of which the cutters can be started and stopped within a small fraction of an inch. While the cutting direction is being changed by the turret or by hand, a succession of pressures on the foot treadle controlling the clutch causes a corresponding stopping and starting of the cutters while the difficult cut is being made. Because it is thus possible to reduce the operating speed to a small proportion of the full cutting speed, only one driving speed is necessary. In starting an inside cut, sufficient pressure is provided to force the cutters through the sheet or plate before the cut is started.

The adjustment of this shear is simple and positive. The horizontal and vertical adjustments of the cutters insure correct cutting edge without the cutters coming together and jamming. On small and medium sized work this shear is operated by one man. In shearing large sheets the operator and helper accomplish work formerly requiring several men. From 75 per cent to 95 per cent of the cutting heretofore done expensively only by tinners' shears, the acetylene torch or by punching or cold chiseling can be done quickly, accurately and economically on this shear. It saves the extra expense of cleaning up, such as filing, grinding, etc., that is necessary under former methods, because the turret rotary shear cuts a smooth, clean, square edge.

The turret makes possible a much wider range of work than has been possible on any other type of rotary shear. The lighter models cut parts for automobiles and general sheet metal, such as elbows, tees, hoods, disks, rings, etc. The heavier models shear plates used in building ships, locomotives, boilers, tanks, cars, bridges and structural plate work.

Since the turret makes possible the cutting of all shapes without extra space for swinging the sheet or plate while being sheared less floor space is required around the machine, and machines of smaller throat depth suffice for work formerly requiring a much larger shear.

Combination Hardness Testing Machine

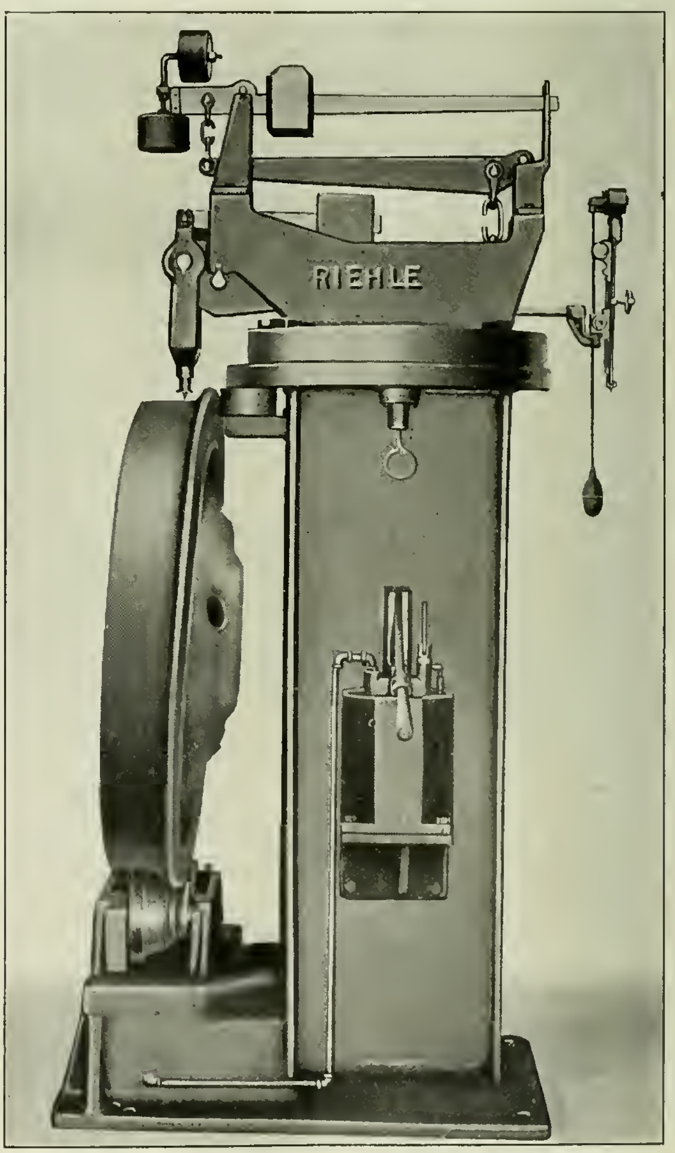
THE problem of making comparative Brinell and scleroscope hardness tests of identically the same spot of metal and on large size pieces is a difficult task where speed of operation and the number of tests made are considered. The Association of Manufacturers of Chilled Car Wheels determined upon an exhaustive study of the hardness of chilled wheels as compared to their wearing and breakage qualities. Tests were to be made to show whether any relationship existed between these properties and incidentally to determine the value of the hardness test as an indication of the general serviceability of the chilled iron wheel.

This study requires hardness tests by both the Brinell and scleroscope methods and on the same spot. No machine being available for this work, the problem was submitted to the Riehle Brothers Testing Machine Company of Philadelphia, and after several conferences with representatives of the association, the machine herewith shown was designed and built. The illustration shows a 33-in., 700-lb. car wheel in position ready for the Brinell test. The method of registering the Brinell load is the well-known Riehle lever and beam system which is considered more dependable than a hydraulic gage reading. At the rear of the machine is shown the familiar Shore scleroscope dart in the circumference of the same circle.

To test a wheel the turntable is revolved 90 deg. from the position shown and a car wheel rolled into place resting on the two grooved rollers. The turntable is now revolved until the scleroscope comes over the wheel. When the center position is reached a pin flies into a hole of the turntable and locks it. The scleroscope is now lowered by its rack onto the wheel and the test reading made. The scleroscope is raised, the pin withdrawn by the eye shown, the turntable revolved 180 deg. when the pin again locks it, and the ball is in position directly over the spot tested by the scleroscope ready for the Brinell test.

The rollers supporting the wheel rest on a hydraulic plunger and a few strokes of the hand pump shown raise the wheel against the ball. When the wheel touches the ball, an initial reading of the depth indicating device is taken. A few more strokes of the hand pump put on the full Brinell pressure which is indicated by the beam rising in the gate. A by-pass valve is momentarily opened, the wheel lowers slightly, a stroke or two of the hand pump again puts the wheel just in contact with the ball and another reading of the depth device taken. The difference between this and the first reading gives the actual depth of impression, even eliminating any flattening there may have been in the ball. The by-pass is again opened, the wheel lowers and the wheel is then revolved to a new position for testing. Thus a series of tests can be made around the wheel.

The depth indicating device mentioned is entirely new and rests in the Brinell head directly above the ball. Two fingers rest on the wheel while a third one rests on the ball. The relative motion of wheel and ball is thus registered without any intervening mechanism and the most accurate depth readings possible are obtained.



Brinell and Scleroscope Hardness Testing Machine

Boring, Drilling and Milling Machine

A NEW line of horizontal boring, drilling and milling machines has been developed by the Pawling & Harnischfeger Company, Milwaukee, Wis., of which the style 4-F machine, shown in Figs. 1 and 2, is the smallest size. This machine is especially designed for heavy milling and large boring operations and can be used either as a single-purpose machine or for general machine shop work.

The machine is modern in design, built to drive high-speed tool steels to capacity limits. There are numerous noteworthy features. Narrow guiding surfaces are used throughout; all feed screws are in tension and all sliding parts are arranged for taking up wear, the saddle is fully counterbalanced with the counterweight located inside the column. Centralized control is provided. All milling feeds are actuated through quick pitch worm and bronze worm wheels, revolving on quick pitch screws in tension. Externally and internally driven face plates are interchangeable; back gears are close to the spindle, making all drive shafts high speed. Automatic stops are used for saddle and column for machines electrically driven.

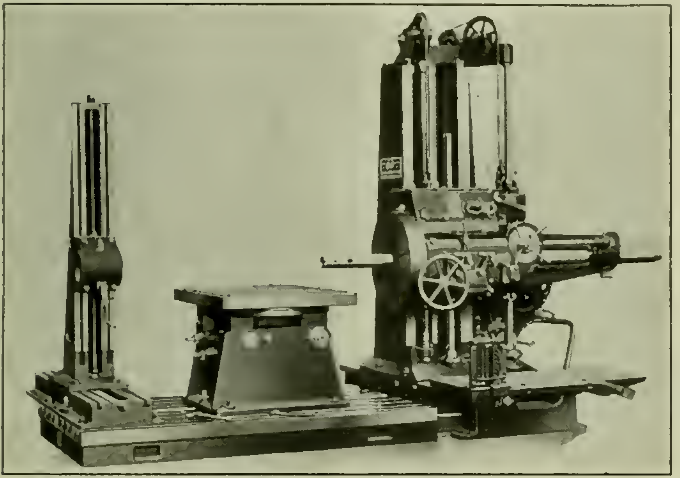


Fig. 1—Front View of Machine Showing Large Face Plate, Standard Spindle, Bed Plate and Outer Support

The spindle-carrying saddle is of box section, well ribbed, and can be handled at any one point, when fully assembled, without fear of distortion. It contains the drive for the spindle, the feeding mechanism and the feed distributing mechanism. All drive gearing and shaft bearings are bronze bushed and the main spindle sleeve bushing is phosphor bronze, scraped to a slight taper for readily taking up wear of the spindle driving sleeve. The saddle is guided upon the column by a narrow guide placed at the front nearest the cutting pressure. The adjustment for wear is made by two steel taper gibs. The screw for feeding is in tension and is placed in the center of the guide. The saddle is fully counterbalanced, the steel cables being placed in the line of the center of gravity. The saddle is raised or lowered on the column by a revolving bronze worm wheel nut actuated by a quick-pitch worm, on a quick-pitch steel screw, either by hand wheel, power feed, or quick traverse.

The column is of heavy box section construction with two sides straight and two sides tapering to a long, wide base cast integral with it. It is guided by long narrow guides placed at the front and near the cutting pressure. The adjustment for wear is made by two steel taper gibs. The screw for feeding the column is in tension and is placed near the guide. The column can be traversed in either direction on its runway by hand wheel, power feed or rapid traverse from the saddle. These movements are through a large revolving bronze worm wheel nut actuated by a quick-pitch worm on a quick-pitch steel screw. The motor is located at the base of the column.

The runway for the column is of rigid construction, very wide, of deep box section and heavily ribbed. All guiding members for the column, saddle and runway are of the square lock type with steel taper gibs to compensate for wear.

The spindle is of high carbon hammered alloy steel forging, ground to a sliding fit in its driving sleeve. The power is applied at the front end and the feed at the rear end through a rack and pinion. This construction provides the spindle with large bearings, front and rear, equally spaced at any point of its travel. The spindle is moved through its changes of feed by spur gears and positive clutches, actuated through a frictional worm wheel. The front end is bored for Morse taper and contains the necessary slots for driving milling cutters and boring bars. The drive is delivered to the spindle through a small face plate with a wide face coarse pitch gear or a larger face plate with internal gear of similar pitch and face. These face plates have slots and tapped holes for the attachment of milling cutters and facing heads.

The spindle-driving sleeve is of semi-steel and is ground to a taper fit in its bushing to compensate for wear. It contains adjustable bronze taper shoes for taking up wear due to the sliding of the spindle in the sleeve.

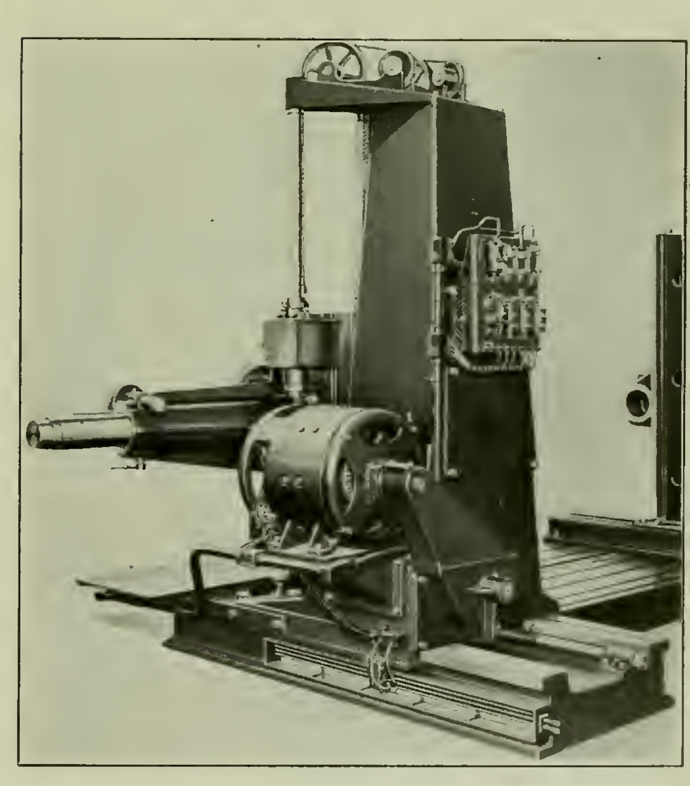


Fig. 2—Rear View Showing Sturdiness of Column and Motor Drive

The drive is by constant speed motor, variable speed motor, or belt. The motor is mounted at the base of the column (10 hp. capacity), and with direct current a two to one variation can be used. The machine is double back geared and by three levers 18 spindle speeds, in either direction are obtained. These spindle speeds are in geometrical progression and range from 5½ to 200 r. p. m. The gears are of special alloy steel, with coarse pitch and wide face.

The boring and drilling feeds to the spindle are eight in number, reversible, and range from 0.0076 in to 0.45 in. per revolution of spindle. The milling feeds to column and saddle are eight in number, reversible and range from 0.009 in. to 0.54 in. per revolution of spindle. These feeds are driving direct from the spindle, back geared and in geometrical progression with no idle gears in mesh. The feed gears and shafts are of alloy steel. Rapid power traverse independent of feeds is transmitted to the saddle and column at a constant speed of 60 in. per min.

All operating levers and hand wheels are within easy reach of the operator and conveniently arranged for the operations required. The starting, stopping, reversing and changing of feeds or speeds, fast or slow, by hand or power, are controlled by the operator on the platform attached to the column. The movements of all levers are interlocking, it being impossible to have any two conflicting speeds or feeds in action at the same time.

The work bed is provided with planed T-slots running parallel to spindle travel. Three sides have a planed squaring stop for alining work. This work bed can be made to any desired size. The outer support, unless otherwise specified, is made with 48 in. vertical and 48 in. horizontal traverse and is adapted for supporting boring bars. Graduated steel scales for the main column and saddle, also the outer support saddle and column, are furnished, reading to 1-1000 in. by use of the verniers. A screw chasing attachment can be furnished to cut threads, varying from 2 to 16 threads per inch and to any length within the capacity of the machine. A universal tilting and revolving table, or a plain revolving table, with movement by hand or power, can also be furnished if the machine is to be used on work requiring such attachments.

The diameter of the spindle is 4 in. and a No. 6 Morse taper hole is provided in the spindle. The feed of the spindle is 36 in. (more if desired by slipping); the vertical travel of spindle saddle, 48 in.; the horizontal travel of column, 48 in. (more if desired in 24 in. additional lengths); the minimum height of spindle from 9-in. bed plate, 25½ in., and the maximum height of spindle from 9 in. bed plate, 73½ in.

Locomotive Driving Wheel Quartering Gage

SIMPLICITY of construction and use are two outstanding features of a new locomotive driving wheel quartering gage, recently placed on the market by the Ashton Valve Company, Boston, Mass. The gage has been designed for use in railroad shops and enginehouses where a quick and accurate means of testing out reported crank-pin irregularities is desired, the reliability and speed with which tests can be made with the gage being strong evidence of its ingenuity and value. The present method of using plumb lines and straight edges, or removing wheels and transporting them to a quartering machine, wastes valuable time of mechanics and helpers which can be greatly reduced by using the new gage. A mechanic can readily test pins for quartering in any position of the drivers without removing them from the frames, requiring but a few minutes per pair of wheels, whereas the old method takes a mechanic and helper several hours. The gage is likewise a time-saver when applying new axles to old wheel centers. By pressing one wheel on its axle and then starting the opposite wheel, gage readings can be taken which will accurately indicate whether the wheel is in the proper position, and if not the necessary amount that it should be moved before being pressed fully on. The quickness with which this operation can be performed will, in a short time, save the initial cost of the gage.

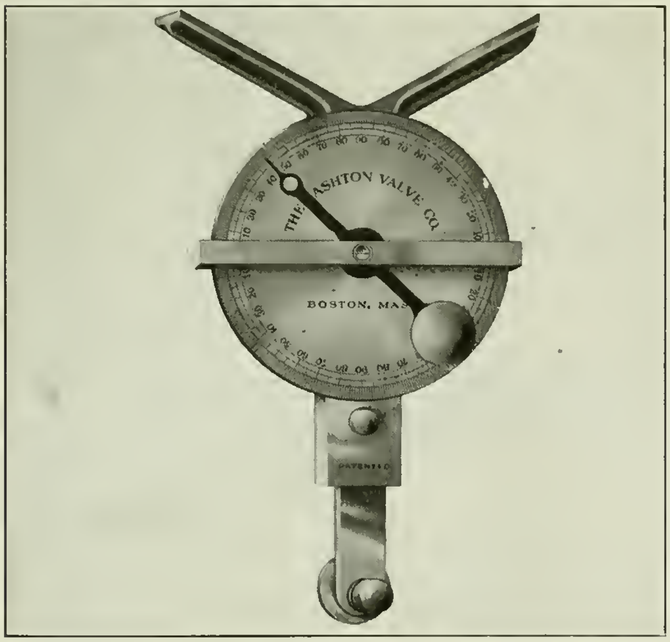


Fig. 1.—General View of Ashton Driving Wheel Quartering Gage

The gage is illustrated in Fig. 1 and its method of use in Fig. 2. It is made to accommodate 24 to 32-in. stroke locomotives, being provided with an adjustable arm *A* (Fig. 2), being held in any desired position by thumb screw *B* and having a ball center *C* at one end for application in the center hole of the driving axle. After *C* is fitted in place the angle end of the gage is raised until the arms *F F* meet the crank-pin. A reading is then taken of the position of pointer *P* on the dial. Pointer *P* is gravity operated by means of the circular weight on the lower end and revolves entirely about the circumference of the dial, sufficient space being provided for the weight to pass between the cross-bar and the graduated dial. The pointer axis is set on hardened steel pivot points and is, therefore, practically frictionless. The weight on the end of the pointer is sufficient to cause the pointer to oscillate and assume an accurate vertical position.

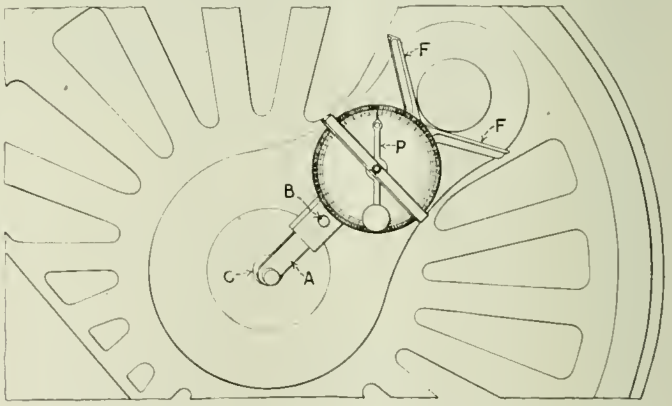


Fig. 2.—View Showing Method of Using Quartering Gage

In operation, readings are taken with the gage first on one driving wheel and then on the opposite wheel. If the sum of the two readings is more or less than 90 deg. it shows that the crank-pins are out of quarter and a change of wheel setting is needed. For instance, should the reading be 44 deg. on one side and 47 deg. on the other, or a total of 91 deg., the pins are out of quarter one degree which, on a 24 in. stroke engine, is equivalent to 15/64 in. Each gage is made of bronze, carefully finished and provided with a substantial box to protect it from injury. With each gage a scale is provided showing the fractions of an inch corresponding to one degree of crank-pin angular variation on 24 in. to 32 in. stroke locomotives. The total weight of the gage is 9½ lb.

Oil-Pressure Transmission and Feed Control

ENABLING a machine tool operator to work heavy carriages and rams quickly and without physical effort is one of the advantages of the Oilgear feed control developed by the Oilgear Company, Milwaukee, Wis. This control allows the operator readily to increase the feeds when cuts become lighter, back out the tool for observing the cutting edge, and return it at will. It also makes it possible to use two or three different feeds in quick succession, when the cuts only last a short time.

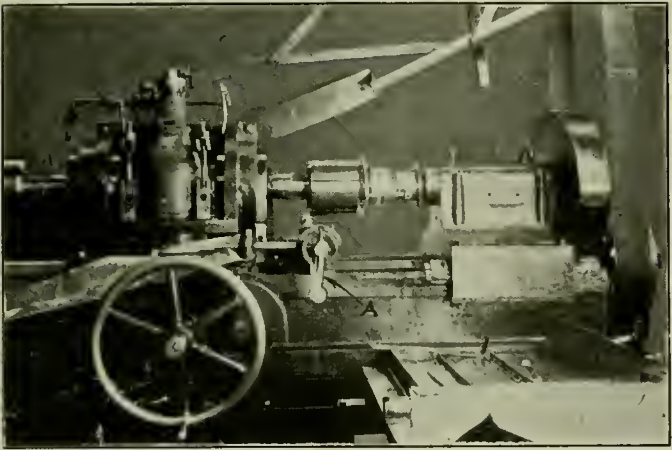


Fig. 1—Front View of Heavy Two-Head Boring, Facing and Tapping Lathe Equipped with Oilgear Feed Control

In many cases the improvement to be effected justifies an installation on machine tools already in operation. Such a case is the double-headed boring and tapping lathe (Fig. 1) which shows the control handle *A* within easy reach of the operator. Fig. 2 shows the Oilgear feed controller *B* and motor *C* installed at the rear of the lathe, with feed control rod *R* extending through to the front. Before this installation was made, the operator had to turn the large hand wheel more than 70 turns, requiring more than one-half minute of hard work in every eight-minute period, in order to back out the tools and place a new casting in the jig. In addition, the facing cut had to be fed by hand as the existing feeds were not suitable. It is stated that in this case the speeding up of rapid traverse and the economies due to correct feeds and greater convenience of manipulation, made possible a total increase in production of 25 per cent.

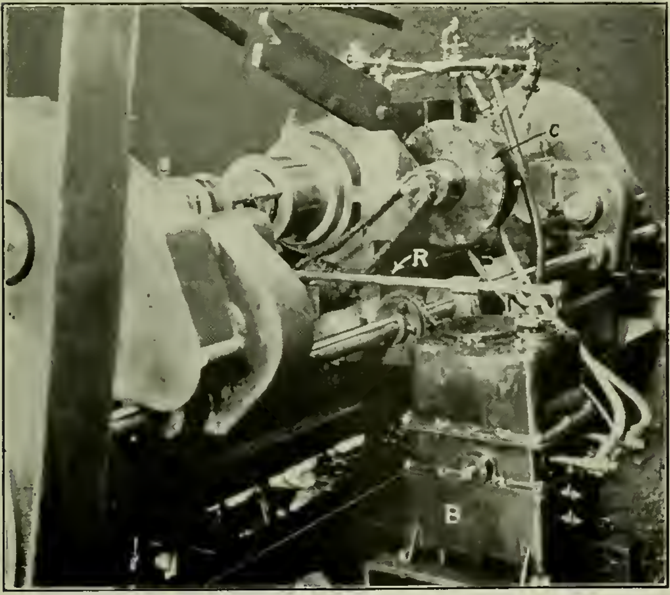


Fig. 2—Rear View of Lathe Shown in Fig. 1

Delivery of fluid from the feed controller, varied in quantity and direction, compels the feeding motor to perform exactly the function desired by the operator. The pressure in the system is large or small according to the resistance offered to the cutting tool, but the feed motor moves at the exact rate of speed called for by the operator, without regard to the pressure which it must exert to do the work. If this pressure rises above the maximum required for feeding, a relief valve opens and permits the feed motor to come to a standstill without damage. This function is made use of in locating shoulders, etc., in work to be machined, as it is only necessary to set rigid stops and let the carriage run against them as desired.

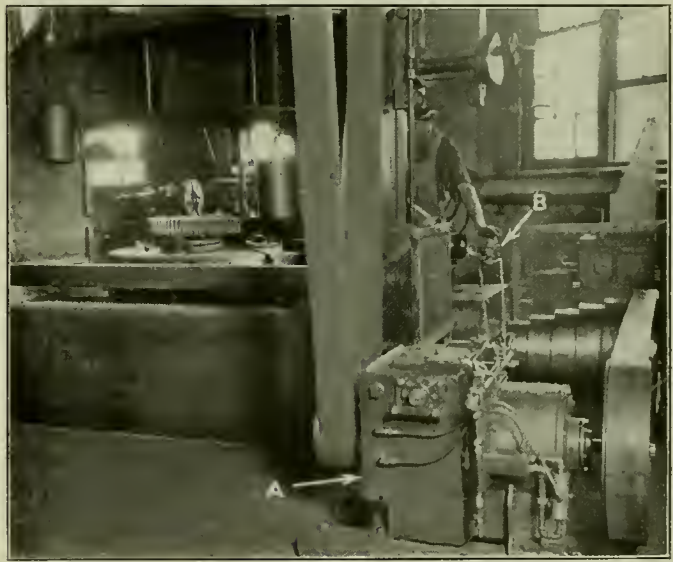


Fig. 3—Rear View of 7-Ft. Boring Mill Equipped with Oilgear Variable Speed Drive

The same functions of variable speed, rapid traverse, accurate control, etc., make the Oilgear system valuable for planer drive or hydraulic press operation.

Variable Speed Drive for Machine Tool Spindles

The Oilgear Company has also developed a larger type of machine designed to drive the spindles of machine tools at any desired speed, from line shaft, constant speed electric motor, or gasoline engine. The unit, shown at *A*, Fig. 3, is of about 10 hp. capacity, designed for driving lathes, boring and milling machines, etc. The principle of operation is similar to that of the feed control system, securing for the operator an infinite number of speed changes in either direction through the manipulation of one single control handle. These functions and speeds selected by the operator are obtained irrespective of changes in load unless the load becomes excessive in which case an automatic overload gear relieves the operator of responsibility by preventing him from overloading the machine. The overload gear may be adjusted to any desired maximum load up to the capacity of the machine. When this is exceeded, the speed will be reduced, even to stopping the tool entirely in case of a jam. The control valve is located at *B*, Fig. 3.

Combination Fibre and Metallic Packing

An unusual and interesting rod packing, said to combine the adjustment features of non-metallic packing with the wear-resisting qualities of metallic ring packing, is V-Pilot Packing, made by Pilot Packing Company, Inc., Chicago. The packing takes its name from the patented contour of the metal which is shaped like a "V" to insure an entirely metallic surface on the rod at the slightest pressure of the gland. The face of the metal, as shown in Fig. 1, is slotted, the slots being staggered to prevent the escape of steam down the rod. The slots serve another useful purpose by retaining oil for the lubrication of the rod. A hasty glance at Fig. 1 may give the impression that there are two pieces of metal instead of one, but on closer examination the V-shape of the solid, white metal bar is apparent.

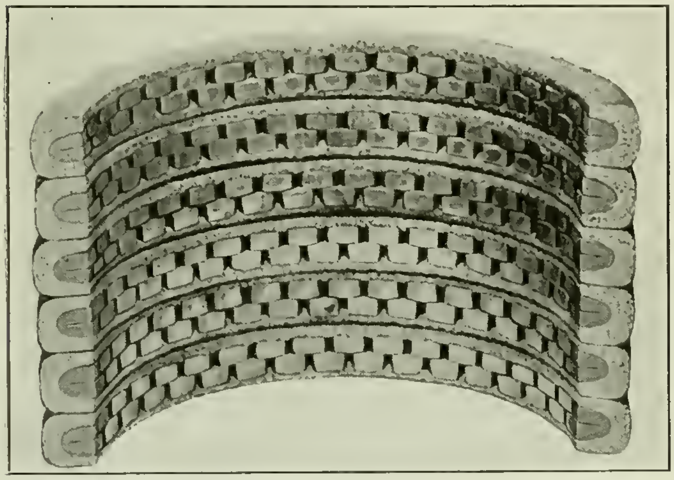


Fig. 1—Cross Section of a Set of "V" Pilot Packing

"V" Pilot Packing has a resilient, pliable back, fitting it for many uses for which purely metallic packing is not adapted. Its extreme flexibility, as shown in Fig. 2, permits its use on small rods and provides easy and quick adjustment. This packing has successfully passed the experimental stage and demonstrated its value by extended tests under actual working conditions, having shown unusually long life and resultant economy. It has a wide range of application and is used by railroads for air pumps, boiler feed pumps (steam and water ends), valve stems, throttle stems, power reverse gear rods, stationary air compressors, steam engines, hot and cold water pumps, ammonia pumps, roundhouse washout pumps, power plant feed water pumps, pumping station (steam or water glands), steam hammers and many other purposes. "V" Pilot Packing is supplied boxed and ready for immediate service and is applied in the same manner as ordinary fibrous packing.

Fig. 2—View Showing Flexibility of New Packing

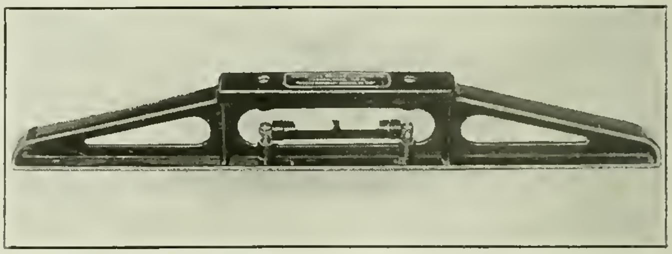
A New Precision Machine Alining Level

The Universal Boring Machine Company, Hudson, Mass., has just placed on the market a precision machine alining level which is different both in design and construction from previous prevision levels. The frame is of cast iron, truss construction, of sufficient strength to eliminate strain and the length of the levelling surface is 27 in.

The vial used is made of Jena glass, especially ground, and is filled and guaranteed by a prominent level maker. The vial is set in a brass japanned case which in turn is mounted on two lacquered brass studs, one at each end. After adjustment, the vial is locked by two nuts working against each other. The adjustment also has a cross travel. This ensures all adjustments similar to those on the finest surveying instruments. The bubble in the vial has a sensitiveness of 5 sec. of arc per graduation, equivalent to 0.0002908 in. per ft. The vial is carried in such a manner that protection from breakage is assured.

The level casting is thoroughly insulated from the palm of the hand by means of a handle of non-conductive material and consequently distortion from this source is completely eliminated.

In constructing the level the casting is first planed and drilled and allowed to thoroughly season. After the metal has proved its season, the base is hand scraped and tested. It is then allowed to rest for a period and is tested again. The vial is then adjusted. The instrument is furnished with a case and is equipped with a strong brass handle thus enabling it to be conveniently carried by service men on the road. The weight is 9¾ lbs.



Level Designed for Accurate Work

Seventy-foot mail storage cars having become common, the Postmaster General and the Railway Mail Pay Committee have petitioned the Interstate Commerce Commission to approve the use of such cars at a pro rata increase over the rate for 60-foot cars.

Railway Mechanical Engineer

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WE GUARANTEE, that of this issue, 7,800 copies were printed; that of these 7,800 copies, 7,080 were mailed to regular paid subscribers, 10 were provided for counter and news company sales, 235 were mailed to advertisers, 8 were mailed to employees and correspondents, and 467 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 92,850, an average of 9,285 copies a month.

The *Railway Mechanical Engineer* is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.)

The American Railway Association now has a Safety Section in the Operating Division, with a temporary Committee of Direction.

The Interstate Car Company, Indianapolis, Ind., will build an addition to its foundry in that city, 91 by 126 ft., at an approximate cost of $25,000.

A fire in the roundhouse and local shops of the Erie Railroad at Jersey City, N. J., on September 11, destroyed one building, partly destroyed another one and damaged 18 locomotives; estimated total loss $100,000.

The New York, New Haven & Hartford has bought from the International Motor Company three gasoline motor cars, supported by special trucks, with seating capacity of 35, also compartment for baggage. Delivery of these cars is expected early in December and they will be used in short haul passenger service on branch lines.

Edgar E. Clark, formerly chairman of the Interstate Commerce Commission, and Wilbur La Roe, Jr., have formed a partnership under the firm name of Clark and La Roe for the handling of matters before the agencies of the government, including the committees of Congress. Their offices will be in the American National Bank Building, Washington, D. C.

London to Birmingham in two hours is the time advertised for the best trains in the latest time-tables of both the London & North Western and the Great Western Railways. This is the first restoration of these fast schedules, which were discontinued during the war. The distance between the two cities, by the North Western, is 113 miles, and by the Great Western, 110 miles.

Trains on time (passenger trains) on the Pennsylvania Railroad in July numbered 94.2 per cent of the total passenger trains operated; and 96.8 per cent made schedule time. This is an improvement of 16.8 per cent and 9.0 per cent respectively over the figures for March, 1920, the first month after the property was returned to the Pennsylvania management. Engine failures and car failures have been reduced.

C. L. Bardo, general manager of the New York, New Haven & Hartford, on September 5, sent out a notice to all employes advising that not one employee had been killed during the month of August, and congratulating them on their successful adherence to "safety first" in their work. Once before—in May, 1920—a similar record was made. This road operates about 2,000 miles of lines with about 1,200 locomotives.

The question of resuming hearings in the general railway investigation before the Senate committee on interstate commerce has been postponed, to be decided at a meeting of the committee following the Congressional recess. There is some sentiment in the committee for discontinuing the hearings, but strong pressure is being brought by others to hear testimony from the labor and other interests not represented at the hearings so far.

Veteran Employees' Associations are being organized on all divisions of the Pennsylvania Railroad, which have not already organized, and campaigns are going on to increase the membership of those associations already in existence. As soon as the divisional organizations are perfected it is planned to hold a Pennsylvania System convention. Approximately 38,778 employees are eligible for membership in these associations by virtue of 20 years of service; that is, one employe in five. Many of the 6,185 former employees now on the pension roll are members of the division veterans' association. These associations were first started in 1897, and they have been among the active factors in perpetuating those traditions and ideals of public service and mutual co-operation between officers and men which have been handed down through 75 years of Pennsylvania Railroad history.

Seven new rules, recognizing and continuing the principle of punitive pay for overtime work in railroad shops, have been promulgated by the Railroad Labor Board as the solution of one of the stumbling blocks in the negotiation of new agreements regarding rules and working conditions between many railroads and their shop employees. These new rules, which are effective as of August 16 and are retroactive to July 1, also recognize and sanction the principle of the eight-hour day, the policy of paying time and one-half for work performed on Sundays and holidays except that work which is absolutely essential to continuous operation and the practice of paying an allowance to an employee called but not required to work. On the other hand, the provisions of the seven new rules so change the overtime rules in the Shop Crafts Agreement that several of the wasteful effects brought to the attention of the Board during the hearings on national agreements will not be continued.

Study of Wood Seasoning

The Forest Products Laboratory, Madison, Wis., in cooperation with saw-mills and wood utilization plants throughout the country, is organizing an extensive field study of the air seasoning of wood. The purpose is to determine the piling practice which will result in the fastest drying rates consistent with the least depreciation of stock, the least amount of yard space required and the least handling costs. All the important commercial woods of the United States will receive consideration. The study of both hard and soft woods will be carried on concurrently. This investigation will furnish a comparison of the effects of such piling variables as the spacings of boards in layers, the height of pile foundations, and the directions of piling with relation to prevailing winds and yard alleyways. It is expected that the study will determine whether lumber should be dried partly at the mill and partly at the plant of utilization or whether it should be dried completely at the mill. Data collected are expected also to show whether air seasoning or kiln drying is more economical.

Ohio Man Appointed American Purchasing Agent for Chinese Government

Charles H. Kettenring, president of the Defiance Machine Works, Defiance, Ohio, has been appointed purchasing agent in America for the republic of China. Mr. Kettenring will have charge of purchases in this country of practically all classes of equipment and supplies of a mechanical or engineering nature.

New Zealand's Premier Favors British Manufacturers

W. F. Massey, prime minister of New Zealand, speaking at Darlington, England, is quoted by the Times (London) Trade Supplement as saying that in his dominion British goods are now given preference and that he hopes that more can be done in that direction in the next few months. He states further that New Zealand is coming to Britain soon to place orders for 2,500 freight cars, 45 locomotives and a quantity of rails.

Purchasing Department Changes on Japanese Government Railways

The financial and purchasing department of the Japanese Government Railways has organized a new section for the purpose of making extensive purchases of modern labor-saving machinery for the mechanical and engineering departments. This section, which will be under the direction of Shinji Sogo, will also arrange for the purchase and installation of modern equipment for the railway's offices.

Anthracite Shipments, August, 1921

Shipments of anthracite for August, as reported to the Anthracite Bureau of Information, Philadelphia, amounted to 5,575,115 gross tons, as compared with 5,462,760 tons in the preceding month, and with 6,207,653 tons in August, 1920. The decrease from August, 1920, was due chiefly to continued light demand for all sizes except stove, and to a continuance of scattered colliery suspensions caused by market conditions and petty strikes.

Implement Manufacturers Urge Abrogation of All Labor Agreements

W. H. Stackhouse, president of the National Implement and Vehicle Association, has issued a statement setting forth the association's ideas regarding the railroad labor problem. Mr. Stackhouse urges as imperative that the "iniquitous Adamson law" be repealed, and, in addition, that the Labor Board be directed "to abrogate all labor agreements, including the unionization of our great transportation system."

150 Cars, Eleven Miles an Hour

On August 7, the Ann Arbor Railroad ran what is said to be the longest freight train ever operated in the State of Michigan. It was from Owosso, Mich., southward to Toledo, Ohio 104 miles. The train left Owosso at 6:15 a. m., with 53 loads and 97 empties, weighing 3,932 tons, and arrived at Toledo at 4:00 p. m., with 53 loads and 98 empties, weighing 3,951 tons. It was hauled by one locomotive of the Santa Fe type with 70,000-lb. tractive effort, equipped with duplex stokers, except that a pusher was used for four miles out of Owosso.

Tentative Consolidation Plan

A tentative plan for the consolidation of the railway properties of the continental United States into 19 systems with one alternative plan for the New England lines, was made public by the Interstate Commerce Commission on Wednesday, September 28, and served upon the railroads and state authorities as the basis for a plan to be ultimately adopted by the commission, in accordance with the provisions of paragraphs 4 and 5 of Section 5 of the interstate commerce act, after public hearings, the dates for which have not yet been announced.

Two Roads Secure Excellent Results from Water Treatment

Reports which have been prepared by the Missouri Pacific and Illinois Central on the operation of their respective systems of water softening for 1920 indicate that water treatment on both of these roads is being attended with highly profitable results. The Missouri Pacific reports a saving for the year of $481,129 through the use of treated water, a figure representing a return of 197 per cent on the total amount invested in treating facilities, while the Illinois Central reports a saving for the year of $292,456, or about 120 per cent on the total investment.

Railway Electrical Engineers Will Not Meet

The 1921 annual convention of the Association of Railway Electrical Engineers has been postponed indefinitely. This action was taken by its board of directors as a result of a suggestion made recently by the Association of Railway Executives that the various sections of the American Railway Association postpone indefinitely all conventions or curtail them as much as possible. The Association of Railway Electrical Engineers is not officially connected with the American Railway Association, but has applied for membership.

A Short Lived Strike in Ireland

Enginemen on the Great Northern of Ireland went out on a strike at midnight of August 29, but returned to work the following afternoon on the advice of J. H. Thomas, general secretary of the national Union of Railwaymen, according to the New York Times. Mr. Thomas advised the men to go back to work after the company agreed to participate in the Irish railway arbitration then in progress. The Irish railways were returned to their owners on August 15 at the same time as the British railways were returned, but legislation similar to that provided for the roads of Great Britain has not been extended to the Irish railways

Some Unit Costs Show Reduction

The Interstate Commerce Commission's monthly bulletin of freight and passenger train service unit costs for the month of June shows a further reduction in some of the unit costs of railroad operation. The cost per freight train mile for selected accounts used by the commission was $1.753 for the month as compared with $1.89 last year and the average cost per passenger train mile, selected accounts, was 98.4 cents as compared with $1.03 last year. For the first six months of 1921, however, the average cost per freight train mile was $1.95 as compared with $1.85 last year and per passenger train mile was $1.07 as compared with $1.01 last year.

Pennsylvania Pensions

During the first six months of 1921 the Pennsylvania Railroad paid out $1,354,692 in pension allowances to retired employees; and 696 new names were placed on the pension list in that time. During the same period, 287 retired employees died. The total number now receiving pensions is 6,406. It is estimated that the average term of service of these men is 40 years. The average age of all employees on the roll is 73 years and 1 month.

All officers and employees who attain the age of 70 years are automatically retired, and those from 65 to 69, inclusive, who after thirty or more years in the service become disqualified for active duty, are also eligible for pensions.

Electrification of Japanese Railways

The official plan for the electrification of the railways of Japan has recently been revised and a new electric bureau established, according to information published in Commerce Reports. According to the plan now being worked out by the Department of Railways, the first steps will be to electrify the entire Tokaido line, the traffic of which has been increasing enormously each year, from Tokyo to Kobe, and a part of the Central line between Iidamachi station in Tokyo and Kofu, in the rear of Mount Fuji, where many tunnels make transportation slow. Electric trains will be used exclusively for passengers, freight trains being operated by steam as at present.

Unemployment Conference

The unemployment conference called by President Harding to inquire into the volume and distribution of unemployment and to consider measures that would tend to recovery of business convened at Washington on September 26. After listening to addresses by the President and by Secretary Hoover of the Department of Commerce, the conference organized by appointing nine sub-committees on various phases of the subject: Unemployment statistics; employment agencies and registration; emergency state and municipal measures and public works; emergency measures by manufacturers; emergency measures in transportation; emergency measures in construction; emergency measures in mining; emergency measures in shipping, and public hearings. Following the appointment of the committees, the conference itself adjourned to October 5, by which time the specialized committees are expected to report.

Reduction in Employees and Their Compensation

A further reduction in the number of employees and the total payroll of the railroads for the second quarter of 1921, as compared with the first quarter, is shown in the Interstate Commerce Commission's quarterly summary of statistics on employees' service and compensation for Class I roads for the three months ending June 30. The average number of employees for the quarter was 1,568,143 as compared with 1,691,471 in the first quarter of 1921. In the third quarter of 1920, when the number of employees was at the maximum, the total was 2,157,989. The number in service at the middle of the month was 1,542,716 for April, but increased to 1,575,599 for May and 1,568,143 for June. The number in service in April was 655,108 less than it was last August.

The total compensation for the second quarter of 1921 was $699,684,795 as compared with $757,325,356 in the first quarter of 1921 and $1,052,109,451 in the third quarter of 1920. The total payroll for the 12 months ending June 30, 1921, was $3,491,000,000.

C. C. McChord Elected Chairman of I. C. C.

Commissioner Charles Caldwell McChord was unanimously elected chairman of the Interstate Commerce Commission on October 3, succeeding Edgar E. Clark, who recently resigned as a member of the commission to engage in private practice.

Mr. McChord was born December 3, 1859, at Springfield, Ky. He was educated at Center College at Danville, Ky. After leaving college he became a member of the bar of Kentucky and engaged in the general practice of law. He was prosecuting attorney at Springfield from 1886 to 1892. He was appointed a member of the Kentucky Railroad Commission in May, 1892, and elected chairman. He resigned in 1895 and was elected a member of the Kentucky state senate, serving four years. During this time he was the author of the bill which became popularly known as the McChord railroad law, empowering the railroad commission to prescribe freight and passenger rates for railroads in Kentucky. He was again elected a member of the railroad commission in 1899 and was again made chairman. He was re-elected commissioner and chairman in 1903 and in December, 1910, was appointed member of the Interstate Commerce Commission. He was re-appointed by President Wilson for the term expiring at the end of 1922.

District Court Issues Decision in Stoker Suit

The suit brought by the Mechanical Construction Company against the Locomotive Stoker Company for infringement of Patent No. 979,849 to William T. Hanna, was tried before Judge Thomson in the District Court of the United States for the Western District of Pennsylvania in February and March, 1921. The defendant denied infringement, alleged the invalidity of the patent, and by way of counterclaim alleged infringement by the plaintiff of Patent No. 1,130,443. The plaintiff in reply denied the validity of this patent or infringement thereof and asked that the counterclaim be dismissed.

The claim of the Hanna patent covered the use of diverging channels in the distributor plates for the distribution of coal in the firebox. In this suit the decision states, "The claims in suit I find valid and infringed." The counterclaim was based on a fuel receptacle below the firing floor, in regard to which the decision states, "I find that for the reason set forth in this opinion, defendant's counter claim should be dismissed."

The case has been appealed by the Locomotive Stoker Company and it is expected that it will be heard by the upper court early in the October term.

Locomotive Orders

The Chilean State Railways have ordered 10 Mikado type locomotives from the Baldwin Locomotive Works, and 20 Mikado type locomotives from the American Locomotive Company.

Freight Car Orders

The Tientsin-Pukow has ordered from the Pressed Steel Car Company 10 first-class sleeping cars, 10 second-class sleeping cars, and 10 third-class sleeping cars, 5 dining cars, 5 drawing-room cars, 5 baggage, 5 postal and 3 private cars.

The Bangor & Aroostook, which has been contemplating the purchase of 200 single sheathed box cars of 40-ton capacity, has ordered this equipment from the Standard Steel Car Company.

Shop Construction

New York Central.—This company has awarded a contract for the construction of a 30-stall roundhouse and annex buildings at Solvay, N. Y., to the W. M. Ballard Company, Syracuse, N. Y. Construction was resumed recently on this project.

Chicago, Rock Island & Pacific.—This company has awarded a contract to the T. S. Leake Construction Company, Chicago, for the erection of an addition to its roundhouse at Eldon, Mo., to cost about $40,000.

Chicago, Burlington & Quincy.—This company will construct a 30-ft. by 50-ft. brick machine shop at Herrin Junction, Ill., with company forces.

Bad Order Cars

According to reports compiled by the Car Service Division of the American Railway Association, the number of bad order cars on August 15 totaled 382,440, or 16.6 per cent of the cars on line. The number of bad order cars on September 1, however, showed a slight reduction, the total being 374,087, or 16.2 per cent. Three hundred and seventy-four thousand, four hundred and thirty-one cars were reported in need of repair on September 15, or 16.3 per cent.

Surplus Serviceable Cars

According to reports compiled by the Car Service Division of the American Railway Association, the surplus serviceable cars on August 15 numbered 284,338, a decrease of 13,446 cars when compared with the total for the week ended August 8.

On August 23, the cars totaled 270,024, a decrease of 14,314 cars when compared with the total on August 8.

The total for the week ended August 31 was 246,440, a decrease of 23,584 cars as compared with the preceding week.

For the period September 1 to 8, a total of 237,972 surplus cars was reported, a decrease of 8,468 when compared with the total for the week ended August 31.

The report for the week ended September 15 showed a total of 219,991 surplus freight cars, a decrease of 17,981 cars when compared with the preceding week.

Extending Electric Traction in Italy

The new work for extending electric traction in Italy, which was decided upon before the war by the State Railways in agreement with the government provides for the electrification of about 2,800 miles of the State Railways. The lines chosen are those where the most coal is consumed on account of the steep grades and very heavy traffic. The total length of line operated by the State Railways, is 8,700 miles and the annual consumption of coal is about 2,500,000 tons. The electrification of 2,800 miles, decided upon in the May, 1920, program, will permit of a saving of 1,300,000 tons of coal, or nearly half of the total amount required for running the entire system. In its place, 600,000,000 kw. hr. per annum will be consumed and this means that power stations will have to be provided with a capacity of 150,000 kw.

Most of the electric power will be purchased from private power distribution companies, but in order to speed up the work the State Railways have already commenced to build large hydro-electric installations which will operate in parallel with the power stations of the private companies.

Steel Passenger Cars for the Northern Pacific

Sixty-two passenger cars are being rebuilt by the Pullman Company for the Northern Pacific which will be used on trains

Nos. 1 and 2 running between St. Paul and Seattle. A part of the order has been delivered to the railroad company and when completed will consist of 22 coaches, 12 diners, 11 dynamo baggage cars, 12 baggage cars and five mail and express cars. Three business cars are also being rebuilt in similar manner. All of the equipment used on these trains will then be steel. The cars are similar to the latest design of Pullman cars and are built of wood with steel underframes and ends and ⅛-inch steel sheathing. The trucks were reinforced to carry the added weight. The advantages ascribed to this type of construction over the all-steel construction are that they are less noisy, are warmer in winter and cooler in summer and more resilient in case of impact The head end system of lighting with power supplied by a steam turbine driven generator, located in the baggage car, is used on these trains. New switch panels were added to the cars, but the lighting fixtures were not changed. Storage batteries will be used on each car, excepting coaches and straight baggage cars.

Professor E. C. Schmidt Returns to University of Illinois

Edward Charles Schmidt has been appointed professor of railway engineering at the University of Illinois, and head of that department. Professor Schmidt was associate professor and professor of railway engineering at the University for 11 years up to November, 1917, when he resigned to enter military service as Major of Ordnance. He was graduated from Stevens Institute of Technology in 1895 with the degree of mechanical engineer. He was connected with the Kalbfleisch Chemical Company, New York and Buffalo; with the Edison Electric Illuminating Company of Brooklyn, N. Y., and with the American Stoker Company. He first went to Urbana in 1898 as instructor of machine design. After five years there he went into the employ of the American Hoist & Derrick Company of St. Paul, and in 1904-06 he was engineer of tests with the Kerr Turbine Company.

After a comparatively short time in the Ordnance Corps, Professor Schmidt was requisitioned by the Fuel Administration, and later was transferred to the Railway Administration in charge of the campaign for fuel economy in locomotive service. From August, 1919, until the present time, he has been mechanical engineer for the North American Company.

Constitutionality of Election Laws to Be Tested by C. M. & St. P. Officers

H. E. Byram, president of the Chicago, Milwaukee & St. Paul, Burton Hanson, general counsel, L. K. Silcox, general superintendent of motive power, and George T. Martin, assistant to Mr. Silcox, were placed under arrest on September 26 before Judge F. S. Righeimer of the Cook County Court, Chicago, on warrants charging violation of the election laws by refusing to pay employees for two hours during which they were absent from their work to cast ballots on election days. Mr. Byram and the other officers appeared before the court voluntarily with the object of making this a test case. The officers furnished bonds of $1,000 each and their case was set for hearing on October 17.

Attorneys representing the four officers of the St. Paul have filed a brief containing 17 reasons why that section of the election law giving employees two hours with pay in which to vote is unconstitutional. Among other points, the attorneys contend that the act is invalid because "it is contrary to the policy of law that any person should be paid for performing that duty of citizenship which consists in attending the polls and voting at elections." Another contention is that the act "seeks to take the property of one citizen for the private use of another citizen."

Federated Shop Crafts Announce Strike Vote

Railroad shop employees, members of the Federated Shop Crafts, have decided by a "constitutional majority," to strike in protest against the recent wage reduction authorized by the Railroad Labor Board, according to the announcement made by B. M. Jewell, president of the Railway Employees' Department of the American Federation of Labor, at a mass meeting of shop employees at Chicago on September 18. Mr. Jewell stated that no strike had been called because the organization leaders believed that their cause will be considerably strengthened if the contemplated strike is called in protest against changes both in the wage scale and in the rules and working conditions.

General charges that the railroads were opposing the demands of the organizations as part of the movement which Mr. Jewell said was backed by "nine billion dollars or more" were made. The object, he said, was "to crush organized labor." In support of this charge he cited the "unfair action of the railroads in offering to negotiate working rules on each road and then failing to agree."

N. P. Good, chairman of the Pennsylvania System Federation No. 90, expressed his opinion that the Pennsylvania had been selected by the railroads to conduct a fight for the "open shop" as the first step in a campaign which would eventually involve all the railroads. Practically all of the speakers at the meeting condemned the Railroad Labor Board and its decisions, Mr. Jewell charging that the railroads were attempting to use the board to take unfair advantage of the present industrial situation.

Freight Car Loading

The total number of revenue freight cars loaded for the week ended August 13, according to reports compiled by the Car Service Division of the American Railway Association, was 808,965, an increase of 24,184 cars when compared with the preceding week. During the corresponding weeks of 1920 and 1919, 162,304 and 23,474 cars, respectively, less were loaded.

During the week ended August 20, 816,436 freight cars were loaded. This was an increase of 7,471 cars over the preceding week, but was a decrease of 151,667 and 96,773 cars when compared with the preceding weeks of 1920 and 1919, respectively.

Eight hundred and twenty-nine thousand, seven hundred and nine cars were loaded during the week ended August 27, an increase of 13,273 cars over the preceding week. During the corresponding week of 1920, 171,599 cars less were loaded.

A total of 830,601 cars was loaded during the week ended September 3, an increase of 892 cars when compared with the total on August 27, and a decrease of 131,032 cars when compared with the corresponding week of 1920.

During the week ended September 10, 748,118 cars were loaded with revenue freight, 82,483 cars less when compared with the total on September 3. This decrease was due to the observance of the Labor Day holiday. One hundred and thirty-five thousand, two hundred and ninety-seven cars less were loaded during the corresponding week of 1920.

The largest number loaded during any one week since the week of December 4, 1920, was reported for the week ended September 17, the total being 853,762 cars. This was an increase of 105,644 cars when compared with the preceding week and a decrease of 137,404 cars when compared with the corresponding week of last year.

Reorganization of Car Service Division, A. R. A.

The Car Service Division of the American Railway Association has been reorganized, and M. J. Gormley has been appointed chairman. The chairmanship will be the point of contact between the Car Service Division and the Interstate Commerce Commission on all details relating to car matters. Mr. Gormley will have general supervision over the activities of the division and will report to the president of the American Railway Association.

Car service managers are W. C. Kendall, A. G. Gutheim, W. J. McGarry, and L. M. Betts. J. J. Pelley is manager of the refrigerator department with headquarters at the Manhattan building, Chicago. C. F. Sewart is manager of the troop movement department and C. A. Buch is secretary. The manager of the refrigerator department will also act as district manager at Chicago. It is proposed to appoint district managers at other important centers if necessary.

The car service managers are assigned as follows: W. C. Kendall to the Railroad Relations Section; A. G. Gutheim to the Public Relations Section; L. M. Betts to the Closed Car Section; and W. J. McGarry to the Open Car Section. The Railroad Relations Section will handle all questions relating to car service and per diem rules, analyze statistics not in the field of other departments, supervise the work of local car service committees, district managers and inspection forces and supervise the placement and cancellation of embargoes. The Public Relations Section will co-operate with government and local authorities other than the Interstate Commerce Commission and make special studies of various classes of traffic from time to time. The sections dealing with closed, open and refrigerator cars will supervise the distribution of the classes of cars assigned to their jurisdiction. The Secretary is responsible for the organization of the division's general office.

Westinghouse Reported to Have Received Large Chilean Contract

The Westinghouse Electric International Company has announced that it has received final confirmation of the contract to supply the equipment for electrifying the Chilean State Railway between Valparaiso and Santiago and to Los Andes, according to the Wall Street Journal.

The contract received from the Chilean government through the company's Chilean agents, Errazuriz, Simpson & Co., associated with Spruille Braden of New York, continues the Wall Street Journal, covers the most important railway electrification since the beginning of the war and the largest ever undertaken by an American firm outside of the United States. The main line, which is 116 miles long and is now under steam operation, is the most important in Chile. It connects the leading seaport, Valparaiso, with the capital, while the line to Los Andes is 28 miles long and forms the Chilean end of the transcontinental route to Buenos Aires.

The contract, which has a total value of $7,000,000, was secured in spite of keen competition from German and other European concerns. The award was given to the American firm because of its more complete and accurate engineering analysis of the proposition as well as its lower price.

The equipment to be furnished consists of 11 passenger locomotives, 15 road freight locomotives and 7 switching locomotives, together with five sub-stations of 4,000 k. w. each. The 3,000-volt direct current system will be used and all standards will be strictly American in character. Capacity of this equipment will be 50 per cent greater than the present traffic demands, and the plans have been so drawn that an increase of traffic capacity to three times the present amount can be readily obtained. Owing to the abundance of water power in Chile and the high price of fuel, practically all of the Chilean railways will probably eventually be electrified and the present project is the first step in this process.

Other American concerns that will participate in additional awards for the requirements of the Chilean railways, according to the Wall Street Journal, are the American Locomotive Company, the Pressed Steel Car Company and the Anaconda Copper Mining Company.

Contracts for Car Repairs

The Erie has entered into a contract with the Youngstown Steel Car Company, Niles, Ohio, for the repair of 400 coal cars, of 50-ton capacity.

The New York Central has given an order for the repair of 250 steel cars to the Cleveland Car Company, Cleveland, Ohio, and for 500 steel cars to the Ryan Car Company, Chicago. This is in addition to the repairs reported in the September issue of the *Railway Mechanical Engineer* for a total of 6,500 cars.

The Illinois Central has placed orders for car repairs as follows: 254 ballast cars and 500 box cars with the Pullman Company; 360 gondola cars with the Haskell-Barker Car Company; 500 box cars with the American Car & Foundry Company, and 400 box cars with the Ryan Car Company.

The Pere Marquette has awarded a contract for the repair of 350 wooden box cars to the International Car Company.

The Southern Pacific, on account of the return of bad order cars to its lines, in larger numbers than could be expeditiously handled by its own forces, is having repairs made to some of these cars at the shops of the Southern Dry Dock & Shipbuilding Company at Orange, Tex. Up to the present time 100 cars have been repaired at these shops.

The Virginian is having repairs made to 100 freight cars at the shops of the Mt. Vernon Car Manufacturing Company.

The Wabash has given an order to the Western Steel Car & Foundry Company, for making repairs to 200 to 250 all steel hopper cars, of 40-ton capacity.

The Chicago, Rock Island & Pacific is having repairs made to 125 general service gondola cars of 50-ton capacity at the shops of the Western Steel Car & Foundry Company, and has also awarded a contract for the repair of 125 steel gondola cars to the Bettendorf Company, Bettendorf, Ia.

The Pittsburgh & Lake Erie has awarded a contract for the repair of 1,000 freight cars to the Standard Steel Car Company.

The Chicago, Milwaukee & St. Paul has awarded a contract for the repair of 300, 50-ton composite gondola cars to the Bettendorf Company, Bettendorf, Iowa, and has also awarded a contract for the repair of 100 composite gondola cars to the Western Steel Car & Foundry Company, Chicago.

Eye Accidents and Faulty Vision Cause Waste in Industries

Eye accidents are revealed as an important source of avoidable national waste in a special report of the Committee on Elimination of Waste in Industry of American Engineering Council, just made public. The report embodies the results of an investigation conducted in many states in connection with the assay of waste in basic industries started by Herbert Hoover.

The total number of industrial blind in the United States is given as 15,000 or 13.5 per cent of the total blind population, this type of injury being the leading causative factor of blindness, according to the report, which was prepared by Earle B. Fowler. The eye, it was found, is involved in 10.6 per cent of all permanently disabling accidents.

Present protective methods as applied in large plants have effected a great reduction in injuries. The use of goggles is one of the chief protective devices. In the plants of the American Car & Foundry Company there has been a reduction of more than 75 per cent through the use of goggles and the percentage of reduction would be much higher if the men would wear goggles more conscientiously, according to the management. Not a single case of injury to the eyes from broken glass has been recorded since goggles were introduced into the shops of the New York Central. All employees of the Union Pacific are now required to wear goggles on eye dangerous work. Striking reductions in eye accidents are also shown by the American Locomotive Company and the American Steel Foundries, eye accidents in the plant of the latter company having been reduced 85 per cent.

The report also states that industrial waste is chargeable to sub-normal vision and faulty lighting. The correction of sub-standard vision produces an increase in return that will pay for its cost in the opinion of the management in plants where several years of trial has provided a basis for judgment. The report states that it has been shown improved lighting systems increase output two per cent in steel plants and as much as 10 per cent in shoe factories where work is more exacting. The cost of providing adequate illumination for the entire industry of the country would amount to one half per cent to one per cent of wages. One estimate placed the loss due to faulty conditions in this country as above the entire cost of illumination. Of the 466 plants investigated, only 8.7 per cent were found to have lighting conditions that could be rated as excellent.

Bids on Equipment for China

Frank Rhea, trade commissioner at Peking, has prepared an interesting analysis of the recent bids of equipment concerns for cars and locomotives for China. The successful bids were not accepted on a basis of price alone, but also on strict adherence to the specifications. The bids were as follows:

Nationality		Nationality	
30 Prairie Type Locomotives			
Belgian	$35,610	German	$49,215*
Japanese	40,296	British	50,878
American	44,200*		
6 British Type Locomotives			
Belgian	34,201	British	43,805
American	43,230*	German	49,540*
3 Pacific Type Locomotives			
American	50,880*	British	53,348
Japanese	39,822	German	53,910*
Belgian	40,525		
2 Mikado Type Locomotives			
American	52,000*	British	55,567
Belgian	43,170	German	57,000*
Japanese	47,408		
100 Open Cars			
Belgian	2.464	Japanese	2,844
German	2,283	British	3,786
American	2,550*		
100 Covered Cars			
Belgian	2,674	American	2,620*
German	2,509	British	4,325

Note—Shanghai Taels shown as dollars at .645.
*Original bid in dollars.

From the above tables it will be noticed that the Belgian and Japanese bids are usually lowest and the British and German the highest with the American bids intermediate. The successful bidders in each case were as follows:

Orders	Successful bidders	Manufacturers
30 Prairie locomotives..	Société Belge pour l'Export. Ind.	Various Belgian manufacturers.
6 British locomotives..	Société Belge pour l'Export. Ind.	Various Belgian manufacturers.
2 Mikado locomotives.	Mitsui Bussan Kaisha.	American Locomotive Company.
3 Pacific locomotives..	Mitsui Bussan Kaisha	American Locomotive Company.
100 Open cars..........	Fearon, Daniel & Co.	Cie, Général de Construction, Belgium.
100 Covered cars.......	Fearon, Daniel & Co.	Cie, Général de Construction, Belgium.

It will be noted that the greater part of the business went to Belgium, because these bids were in most cases the lowest conforming strictly to specifications. The factor of exchange, of course, enters largely into these bids. According to Mr. Rhea, if the Belgian franc would increase from 8 cents to 10 cents in exchange value the Belgian bids would in most cases cited above have been higher than the American bids.

MEETINGS AND CONVENTIONS

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

Division V—Equipment Painting Division. V. R. Hawthorne, Chicago.

American Railway Association, Division VI—Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio.

American Railroad Master Tinners' Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamlin Ave., Chicago.

American Railway Tool Foremen's Association. R. D. Fletcher, 1145 E. Marquette Road, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Society for Steel Treating.—W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Next meeting October 11, Windsor Hotel. Paper on Studies on the Corrosion of Iron and Steel will be presented by Dr. Alberton S. Cushman, Institution of Industrial Research, Washington, D. C.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Meeting second Monday in month, except June, July and August, New Morrison Hotel, Chicago, Ill.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Annual dinner Thursday evening, November 10, at 7:30 p. m. Hon. Charles F. Moore, the Virginia judge, will be toastmaster. A prominent speaker will be present. Dancing and other entertainments.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Meeting second Tuesday of February, May, September and November, at Hotel Sinton, Cincinnati.

Dixie Air Brake Club—E. F. O'Connor, 10 West Grace St., Richmond, Va.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 715 Clarke Ave., Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn.

Master Boilermakers' Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y. Next annual convention Hotel Sherman, Chicago, May 23 to 26, 1922.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting October 11. Paper to be read on Organization Mobilization and Activities of The Canadian Overseas Railway Construction Corps. Addresses by F. L. Wanklyn, chief executive assistant, and Grant Hall, vice-president, Canadian Pacific Railway.

New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y.

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Next meeting October 13. Paper on Locomotive Construction will be presented by Arthur J. Benter of the Baldwin Locomotive Works. Eight reels of motion picture showing locomotive construction.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Next meeting October 27. Annual smoker and entertainment. Election of officers.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Meeting second Friday of each month, except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Next meeting October 17. Paper on Car Owners' Responsibility will be presented by C. J. Wymer, superintendent car department, Chicago & Eastern Illinois.

PERSONAL MENTION

GENERAL

A. W. Kirkland has been appointed acting superintendent of motive power of the Atlanta, Birmingham & Atlantic, with headquarters at Atlanta, Ga., during the absence of J. F. Sheahan.

J. A. Carney, superintendent of shops of the Chicago, Burlington & Quincy, at Aurora, Ill., has been appointed supervisor of fuel economy, with headquarters at Chicago. H. Modaff, master mechanic of the Ottumwa division, with headquarters at Ottumwa, Iowa, will succeed Mr. Carney as superintendent of shops at Aurora. H. C. Turner will succeed Mr. Modaff as master mechanic.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

B. Addison Orland, formerly general foreman of the mechanical department of the Mobile & Ohio at Murphysboro, Ill., has been promoted to master mechanic, with the same headquarters, and jurisdiction from East St. Louis, Ill., to Tamms, Ill. Mr. Orland was born on July 7, 1868, at Cleveland, Ohio, and was educated in the public schools. He began his railroad career on August 4, 1884, in the shops of the Cleveland, Columbus, Cincinnati & Indianapolis at Mattoon, Ill., as a machinist apprentice, entering the employ of the Mobile & Ohio on March 15, 1889, as a machinist at Murphysboro. On March 17, 1891, he was promoted to roundhouse foreman; on February 1, 1900, became general foreman, and on February 1, 1902, was transferred temporarily as master mechanic to Whistler, Ala., resuming his duties as geneal foreman at Murphysboro on January 1, 1903.

G. T. Depue has been appointed master mechanic of the Erie at Marion, Ohio, succeeding R. V. Blocker, resigned. Mr. Depue was born on December 2, 1872, in Hornell, N. Y., and received his education in the grammar schools. On March 1, 1889, he entered the employ of the Erie as a machinist apprentice. After that he worked as a machinist and extra gang foreman until March 1, 1901, when he was promoted to the position of general foreman of the Bradford division, with headquarters at Bradford, Pa. On August 1, 1901, he was appointed general foreman of the Hornell shop; on July 1, 1903, master mechanic at Hornell; on April 1, 1908, master mechanic at Galion, Ohio; on August 1, 1913, shop superintendent at Galion, and on July 1, 1916, shop superintendent at Susquehanna, Pa. On March 1, 1920, when the Erie was reorganized, he was appointed mechanical superintendent of the Chicago region, and on April 1 of this year became shop superintendent at Galion.


G. T. Depue

SHOP AND ENGINEHOUSE

George Canfield, air brake inspector of the Canadian National at Capreol, Ont., has been appointed locomotive foreman, with headquarters at Jelicoe, Ont. Mr. Canfield was born on May 6, 1893, at Eagle Grove, Iowa, and entered the employ of the Canadian Northern in September, 1904, continuing his public school education at night. He served first as a call-boy at Port Arthur, then as a machinist apprentice and machinist until October 14, 1915, when he was subsequently employed as a locomotive foreman at Jelicoe; air brake inspector and assistant foreman at Capreol; locomotive foreman at Brent; machinist at Capreol; locomotive foreman at Foleyet; general foreman at Hornpayne; air brake inspector at Capreol, and on June 12, 1921, was reappointed locomotive foreman at Jelicoe.

SUPPLY TRADE NOTES

Kearney & Trecker, Milwaukee, Wis., announces the removal of its New York office from the Singer building to the Hudson Terminal building, 50 Church street.

J. E. Slimp, formerly with the Ohio Brass Company, and recently with the E. T. Chapin Company, Spokane, Wash., as sales manager with office at Chicago, has resigned.

H. S. Durant has been appointed sales agent, and M. W. Floto assistant sales agent, at the Detroit office of the American Steel & Wire Company, Chicago, to succeed M. Whaling and T. J. Usher, Jr., resigned.

William S. Murray, formerly chairman of the Superpower Survey, and Henry Flood, Jr., formerly engineer secretary of the Superpower Survey, have formed the firm of Murray & Flood, Grand Central Terminal, New York.

Theodore Rogatchoff has been elected president of the Rogatchoff Company, Baltimore, Md., succeeding A. E. Davis. The company has moved its offices in Baltimore from 205 Water street to 1512 Latrobe terrace.

William C. Wolfe has been appointed manager of sales of the Highland Iron & Steel Company, Terre Haute, Ind., a subsidiary of the American Chain Company. Mr. Wolfe's headquarters will be at 208 South La Salle street, Chicago.

R. H. Blackall has been appointed railway sales representative for the New York territory of The Lowe Brothers Company, Dayton, Ohio, with offices at 7 East Forty-second street, New York City and Farmers Bank building, Pittsburgh, Pa.

Thomas Madill, who served for many years in the sales department of the Sherwin-Williams Company, Cleveland, O., died in Los Angeles, Cal., on July 23. He spent practically his entire business life with The Sherwin-Williams Company in its railway trade.

Thomas H. Greenwood has been appointed factory manager of the McDougall-Butler Co., Inc., Buffalo, N. Y., makers of paint and varnish for railway uses. This company has appointed the Ehrlich Paint Company, Cincinnati, Ohio, as its representative in the Cincinnati district.

The Stowell Company, South Milwaukee, Wis., has effected a merger with the Pelton Steel Company, Milwaukee. The Pelton Steel Company name will be retained and the plant will continue to be operated by the same organization, under the direction of the officers and directors of the Stowell Company.

G. H. Redding has been elected secretary of the Massey Concrete Products Corporation, succeeding F. C. Shannon, formerly vice-president and secretary, and the position of vice-president will remain unfilled for the time being. David A. Hultgren has been appointed resident manager at Chicago, for the company.

J. H. McMullen has been appointed railroad representative in the Boston, Mass., territory, for the Western Electric Company, succeeding E. R. Morgan, and E. B. Denison, formerly in charge of the Minneapolis, Minn., territory, has been appointed Detroit, Mich., railroad representative, succeeding R. S. Cowan.

The English Electric Company of Canada, Ltd., a newly-formed company associated with the English Electric Company of Great Britain, has acquired control of the Canadian Crocker-Wheeler Company, Ltd. R. A. Stinson, vice-president and general manager of the latter company, has been elected president and general manager of the new company.

The Metals Coating Company of America, manufacturers and distributors of the Schoop Metal Spraying Process by means of which metallic coatings of any kind may be sprayed onto any surface, is now in full operation at its new plant, 495-497 North Third street, Philadelphia, Pa., having removed from their former Boston, Mass., and Woonsocket, R. I., locations.

A. H. Handlan, Jr., vice-president and manager of the Handlan-Buck Manufacturing Company, St. Louis, Mo., has been elected president of the company, succeeding his father, the late A. H. Handlan; E. W. Handlan, vice-president and treasurer, has been made vice-president; E. R. Handlan, secretary, has also been elected to a vice-presidency, and R. D. Teasdale has been appointed secretary.

Robert D. Black has been appointed manager of the Philadelphia branch office of the Black & Decker Manufacturing Company with headquarters at 318 North Broad street. He succeeds W. C. Allen who has been appointed special factory representative, with headquarters at the Cleveland branch office, 6225 Carnegie avenue. Mr. Black was formerly assistant sales manager of the company.

Fred A. Poor, Patrick H. Joyce, and Edward N. Roth, have been elected members of the board of directors of Mudge & Co., Chicago. There has been no change in the control of the company, its management being as heretofore in charge of Burton Mudge, president, and Robert Sinclair, vice-president. The other directors of the company are Burton Mudge, Robert Sinclair, Egbert H. Gold and Edwin W. Sims.

John C. Robinson has resigned as manager of New England sales at Boston, Mass., for William Wharton, Jr., & Co., Inc., Easton, Pa., after 30 years of continuous service. Mr. Robinson will in future devote his time to his interests in the firm of Harrington, Robinson & Co., Boston. The Boston office of the Taylor-Wharton Iron & Steel Company, High Bridge, N. J., and William Wharton, Jr., & Co., Inc., is now at 201 Devonshire street, in charge of Walter H. Allen.

Edward B. Germain, general manager of the Harlan plant, Bethlehem Shipbuilding Corporation, Wilmington, Del., has been appointed manager of sales of the corporation, with office at 111 Broadway, New York. Mr. Germain went to Wilmington in December, 1918, from Elizabeth, N. J., where he held the position of general manager of the Moore plant of the same corporation. Cecil W. Weaver, formerly general superintendent of the marine department, succeeds Mr. Germain. The Harlan plant, besides its shipbuilding and ship repair facilities, has extensive passenger shops with a capacity of 250 steel passenger coaches a year.

Horace C. Hides, who for the past 20 years represented Wm. Jessop & Sons, Sheffield, England, has been appointed general sales manager in the United States for Thos. Firth & Sons, Ltd., Sheffield. This firm recently terminated its agency arrangement for the sale of sheet steel with Wheelock Lovejoy & Co., of New York and Cambridge. Mr. Hides will have his headquarters in Hartford, Conn., where a joint office has been opened by Thomas Firth & Sons, Ltd., and an associate company, the Firth-Sterling Steel Company, New York; Henry I. Moore will represent the latter company at Hartford.

The Pennsylvania Car Company has been incorporated under the laws of Delaware, with a capital of $1,000,000 to engage in the building of railroad cars. The incorporators are: J. H. Van Moss, James H. Durbin, L. B. Coppinger, and the Corporation Trust Company of Delaware. Plants equipped with latest improved machinery will be constructed at Sharon, Pa., at Argentine station, Kansas City, Kan., and at Houston, Texas. This company is affiliated with the interests that control the Pennsylvania Tank Car Company and the Pennsylvania Tank Line, Sharon, Pa., and the present plans call for the development of one of the largest organizations of its kind in the country.

The Conewango Car Company, incorporated in Delaware, has leased the site at Warren, Pa., formerly occupied by the Allegheny Tank Car Company, which plant was partly destroyed by fire on April 6 last. The new company will specialize in repairs to tank cars. In addition to three buildings on the site which were not destroyed by fire, the new company has built a car shop, a machine shop and a sandblast shop, all of which are being equipped with modern machinery. Shop and yard space is provided for repairing

20 cars at a time, as is storage space for 50 additional cars. N. C. Stiteler is president and treasurer of the new company and J. C. Sullivan is vice-president and general manager.

Charles Haines Williams, first vice-president of the Chicago Railway Equipment Company, died at Chicago on the morning of August 8. Mr. Williams was born in Baltimore, Md., on April 1, 1875, and was educated in the public schools of Baltimore and at the Baltimore Polytechnic Institute, from which institution he graduated in 1893. He later took a special course in mechanical drawing and machine design in the Maryland Institute. After four years as a special apprentice in the Mount Clare shops of the Baltimore & Ohio, where he worked in the machine and locomotive shops, the erecting shop and in the foundry, drafting room and test department, Mr. Williams, on July 6, 1897, left the Baltimore & Ohio to become connected with the Chicago Railway Equipment Company, as mechanical inspector. In 1917, he was elected first vice-president of the company and a director, which positions he occupied at the time of his death.

Edward A Craig, manager of the export department of the Westinghouse Air Brake Company, Pittsburgh, Pa., died on August 28, at his home in Edgewood, Pa. Mr. Craig was born in January, 1873, at Allegheny City, Pa., and was educated in the public schools of that city. He began work in 1888 with the Westinghouse Air Brake Company as a messenger. He subsequently served as secretary to the general superintendent of the works. He later was appointed assistant auditor and then served as auditor and assistant secretary. In 1906, the company established the Southeastern district, with Mr. Craig as manager. He remained in that position until the export department was organized in January, 1920, and since that time he served as manager of the export department.


E. A. Craig

Kenneth Rushton, vice-president in charge of engineering of the Baldwin Locomotive Works, died on September 2 at his home at Wynnewood, Pa. Mr. Rushton was born 60 years ago in Philadelphia, Pa., and was educated in the city schools and Episcopal Academy. He served an apprenticeship, as machinist, under Hugo Bilgram, Philadelphia, and afterward entered the employ of the Baldwin Locomotive Works in April, 1881. Mr. Rushton's association with the Baldwin Locomotive Works continued uninterrupted until the time of his death. He served first as a draftsman, and then as designer, chief mechanical engineer and later as vice-president. He was the inventor of many appliances used in the construction of locomotives, and was closely associated with S. M. Vauclain in the development of the four-cylinder compound that bears the name of the latter. While Mr. Rushton did not travel extensively in the prosecution of his business, he represented Baldwin's abroad in some important missions. In 1913 he was sent to Chile, visiting various points of railroad interest on the west coast of South America, and in 1918 went to France, in connection with the design of railway transport for artillery.


K. Rushton

Carl F. Dietz, vice-president and general sales manager of the Norton Company, Worcester, Mass., has resigned to become president and general manager of the Bridgeport Brass Company, Bridgeport, Conn., succeeding Fred J. Kingsbury, of New Haven, who has been made chairman of the board of directors. Mr. Dietz was connected with the Norton Company for 10 years, first as plants engineer, then as assistant sales manager, and afterward as sales manager of the wheel division of the business. Two years ago, when the Norton Company and the Norton Grinding Company were consolidated, he was made vice-president and general sales manager. He was born in New York, February 12, 1880, and was graduated from Stevens Institute of Technology in 1901. Subsequently he took post graduate work in engineering studies abroad. Early in his career he was active at plants of the United States Steel Corporation in blast furnace operation. In 1905 he engaged in the development of zinc-smelting processes. The following years were spent in consulting metallurgical and mining work, examinations, design and operation of milling plants in North and South America and various European countries. Mr. Dietz is a member of the American Society of Mechanical Engineers, the American Institute of Mining and Metallurgical Engineers, the Worcester Club, Engineers' Club of New York, Quinsigamond Lodge of Masons, Chamber of Commerce, Economic Club, Theta Nu Epsilon, Phi Sigma Kappa and University Club of Worcester.


Carl F. Dietz


W. La Coste Neilson

W. La Coste Neilson, vice-president of the Norton Company, has been appointed general sales manager, succeeding Mr. Dietz. Mr. Neilson was born on May 2, 1879, at Philadelphia, Pa., and graduated from Haverford College in 1901. From 1901 to 1905 he was employed by the Standard Steel Works at Burnham, Pa., and was superintendent of the Chester Steel Castings Company from 1906 to 1907, when he entered the employ of the Norton Company. Mr. Neilson served for a few years as assistant sales manager of the Norton Company, then was in charge of all foreign business, including sales and the management of the foreign plants at Wesseling, Germany, and at La Courneuve, France, with office in London, England. He was made a vice-president two years ago.

Railway Mechanical Engineer

Volume 95 November, 1921 No. 11

CONTENTS

EDITORIAL:
- The June Convention Program 669
- Gasoline Motor Cars for Branch Line Service 670
- Manufacture of Standard Small Tools 670
- Bronzed-Faced Semi-Steel Castings 670
- Henry Ford on Car Design 670
- The Reintroduction of Piecework 671
- Order vs. Disorder 671
- Progress in Boiler Design 672
- Does Gas Cutting Always Pay? 672
- New Books 672

GENERAL:
- Avoidable Waste in Locomotive Operation as Affected by Design 673
- Drop Pits at Terminals on the South African Railways 677
- New Locomotives for the Northern Pacific 679
- Preparation and Distribution of Fuel 682
- Important Factors in Design of Locomotive Boilers 683
- European View of Steel vs. Copper Fire Boxes 685
- Turntable Indicating Device 688

CAR DEPARTMENT:
- Container Cars in Use in Poland 689
- Henry Ford Comments on Car Design 689
- Unnecessary Transferring of Loaded Cars 690
- New Sleeping Cars for the Canadian Pacific 691
- Make Car Owners' Responsibility Complete 695
- A Check on Rough Handling of Cars 696
- Bowen Gasoline Motor Driven Passenger Car 697
- A Combined Car Coupler and Hose Connector 699
- A Chemist in a Freight Car 700

SHOP PRACTICE:
- Labor Board Lifts Piece Work Ban 701
- Three Loomotive Shop Devices 702
- Interesting Examples of Blacksmith Shop Work 703
- Repairing Tube-Sheet Cracks in Locomotive Boilers 704
- Oxy-Acetylene Machine Cutting in Railroad Shops 705
- Construction and Maintenance of Cinder Pits 707
- Table for Oxy-Acetylene Cutting 708
- The Metallurgy of High Speed Steel 709
- Boiler Makers' Committee Reports Released 711
- Cause of Boiler Shell Cracking Through Girth Seam Rivet Holes 712
- Oxy-Acetylene Cutting Tests 713
- Overcoming an Objectionable Column Where Crane Service Was Desired 713

NEW DEVICES:
- Vertical-Spindle Surface Grinding Machine 715
- Constant Speed Drive for Milling Machines 716
- Five-Step Clearance Control for Air Compressor 717
- Knee Type Surface Grinding Machine 717
- Chuck Used With Broken Twist Drills 718
- Bronze-Faced Driving Box Shoes and Wedges 719
- Safety Stake Pocket for Logging Cars 719
- Ease of Operation Features New Portable Drill 720
- Locomotive Throttle Rod Stuffing Box 720
- Receding Die Head for Pipe Threading Machine 721
- Heavy Duty Trailer for Concentrated Loads 721
- Measuring Locomotive and Car Wheel Loads 722
- Easily Detachable Running Board Bracket 722
- Direct Motor Drive Applied to Mortiser 723

GENERAL NEWS 724

The Index for the 1921 Volume

For the past two years the *Railway Mechanical Engineer* has printed only a limited edition of the annual index, which has been mailed to subscribers upon request. As this practice has apparently been entirely satisfactory it will be continued this year. Copies of the index for 1921 will be ready soon after the December issue is off the press and those desiring copies should notify the Circulation Department not later than January 1, 1922.

The June Convention Program

The announcement by the Mechanical Division of the American Railway Association of the decision to hold a convention at Atlantic City in June will meet with general approval among the members, many of whom were disappointed that no meeting was held this year. It is inevitable that interest should decline if no meetings are held and unless the Mechanical Division adopts a constructive and aggressive policy there is danger that it will not retain the proud position held by the Master Mechanics' and Master Car Builders' Associations for so many years.

The possibilities for constructive work were never greater than they are today. As pointed out by Mr. Tollerton in his address as chairman of the 1920 convention, the Transportation Act is causing a greater and more insistent demand for railroad operation under conditions of maximum efficiency. This should be the guiding thought in outlining the work of the association. In the past, and especially in recent years, the mechanical association has not measured up to the broad responsibility that Chairman Tollerton has outlined. The problems of the mechanical department embrace far more than merely the technical problems of the design and operation of equipment. The program of the association has become narrower when it should have widened its scope.

Foremost among the topics that should receive attention is the ever-important matter of an enlightened labor policy. A. H. Smith, president of the New York Central, recently said "The efficiency of a railroad depends principally upon its men. It is estimated that 95 per cent of railroading is human." If the matter is considered merely from the standpoint of the expenditure involved, the importance of the labor question is evident. In 1920 of every dollar spent for maintenance of equipment, 68 cents was paid for labor and 32 cents for materials. Mechanical officers find it advantageous to discuss at the conventions their common problems of getting the best service from material or getting the most power from coal. Would it not also pay them to consider the problems of recruiting, training and supervising labor in order to get the best possible return for the payroll expenditure, which for the year 1920 amounted to over $1,000,000,000 for the mechanical department alone? Surely there is a field for personnel work which the association cannot afford to ignore.

Another big field as yet almost untouched is to be found in the mechanical problems of operation. The question of economical speed and tonnage is of primary interest to the operating officer, but to determine the best practice requires a knowledge of the characteristics of the locomotive which the mechanical department officer alone possesses. It is to be hoped that eventually the mechanical association will number among its committees one on the economics of operation.

Some attention has been given to shop design and management in recent years but much more could be done along these lines. In the equipment field, to which the association has devoted most of its attention in the past, there are notable developments under way. The possibilities before the Mechanical Division are practically unlimited, and if its work is extended to include the big problems which the mechanical department must face, there should be opened to the organization a new era of constructive activity.

Gasoline Motor Cars for Branch Line Service

Considerable interest was aroused a number of years ago in the development of a gasoline-engine-driven rail motor car for use on branch and short lines where the passenger traffic was so light that only one or two trains a day were operated. In many sections there was also an added interest due to the construction of competitive interurban electric roads which, with their frequent regular service, were able to secure a profitable traffic, whereas the railroad with its limited number of trains was failing to earn even operating expenses. To meet this demand a number of different designs were brought out by several companies—some of these cars having mechanical transmission and some electric transmission. Several were excellent examples of the railroad car builders' art and provided every facility to which the traveling public had become accustomed. They were commonly heavy, often larger than was really necessary and required engines of very large size that have since been found to be beyond the practical limits of power for gasoline engines. As these cars could not be profitably operated, railroads lost interest in them.

Since that time there has been a tremendous development in motor truck design and the railroad branch line now is facing the competition of the motor bus running on parallel highways. Many of these railroad lines with their small density of traffic are valuable as feeders and the traffic available would be a profitable source of revenue if it could be handled at a lower cost than is possible by steam locomotive operation. In this connection the fact should not be overlooked that the railroad with its moderate grades, easy curves and steel rails when equipped with motor cars would be able to furnish smoother riding, carry heavier loads and operate such cars at lower maintenance and power costs than is possible for motor cars operated on highways.

What the railroads should do is to make full use of the accumulated engineering experience of the motor truck builders, use engines of a size and design which have already demonstrated their efficiency, employ transmission and other details which have been developed, design a body as light as possible and mount it on well-designed trucks. By so doing the renewed activity in railway motor car construction should soon result in a number of designs which could be operated to advantage and with economy.

Manufacture of Standard Small Tools

Railroad shop tool rooms have frequently been called upon to make milling cutters, reamers and various small tools. The practice often has been started on account of the difficulty in having requisitions passed or the delay in securing devices not regularly carried in quantity in storeroom stock, but which may have been needed promptly to avoid delays in doing necessary work. It having been shown that the tool room was capable of doing the work, there is a tendency oftentimes to continue the practice. It is doubtful, however, whether any railroad tool room has the equipment or can manufacture such small tools in sufficient quantity to do so at a price as low as they can be bought in the open market. In comparing costs it must be remembered that direct labor and material represent only a part and frequently the smaller part of the actual cost. Superintendence, interest and depreciation of machine tools and buildings, power, light, heat and other elements are just as much factors of cost as are the direct labor and material.

Unfortunately railroads do not calculate their costs as accurately as is desirable. Even manufacturing plants with highly equipped tool rooms and which use many times the number of cutters and small tools required by railroad shops have found by careful cost investigation that such devices can be purchased from specialists cheaper than they can be manufactured. The trend of profitable commercial manufacturing is more and more toward limiting the product to a small line which can be produced in a quantity which will warrant the outlay for the most complete equipment of machinery and devices for the particular product and then purchase small tools and other devices, except special jigs and fixtures that are not a regular product of any other manufacturer. Even such devices can and frequently are obtained from some one who makes a specialty of such work. The railroad shop, often with advantage, can learn a lesson from the outside manufacturing shop which watches its costs with extreme care. Except in emergencies and in cases where small tools cannot be procured from outside manufacturers, investigation will show the economy of purchasing instead of making such articles.

Bronze-Faced Semi-Steel Castings

Elsewhere in this issue is an article referring to the development of bronze-faced semi-steel castings which will be of considerable interest to railroad men, especially those who have to do with the maintainance of locomotive parts subject to wear. A foundry company in the Middle West, specializing in the manufacture of castings for railroad uses, has developed bronze-faced, semi-steel castings for which it is claimed that the bronze faces are 30 per cent harder than ordinary bronze and the semi-steel backs about 50 per cent stronger than grey iron. The possible uses of castings of this description are too many for enumeration but the first castings made and tried out were for driving box shoes and wedges, than which no parts of a locomotive are subject to greater use and abuse, wear and tear. The combination of durable wearing surfaces and strong backs provided qualities particularly valuable in shoes and wedges and it is stated that extensive tests over a period of 16 months showed the bronze-faced semi-steel shoes and wedges to be fully up to the claims made for them. During the test period, the entire shoe and wedge problem was studied from every angle including the possibilities of reclaiming the bronze after use. In view of the possible reduction in maintenance costs, further developments in the use of bronze-faced semi-steel castings for locomotive parts subject to severe stress and wear will be followed with great interest by railroad shop men.

Henry Ford on Car Design

Henry Ford's venture into the transportation business promises to be one of the most interesting developments that the railroad world has seen for some time. As a manufacturer, Mr. Ford has been remarkably successful, and even though he is not a railroad man, his opinion on the design of rolling stock cannot be disregarded, in view of his acknowledged ability in mechanical matters. Recently Mr. Ford made a few comments on car design, which are published elsewhere in this issue. His first criticism is that cars are too heavy. This has been a debated subject for at least 50 years, so it will be interesting indeed to see whether the automobile manufacturer will develop some highly original solution of the problem that railroad men have failed to grasp.

In some of the latest high-capacity cars the load amounts to 79 per cent of the total weight. It is hard to see how this ratio can be improved very much without lessening the strength of the car, thus sacrificing the operating advantages of powerful locomotives and long trains. In box cars the weight of the car forms a much larger proportion of the total under average loading conditions, but these cars must be strong enough to withstand the stresses set up by loads of lumber, grain and other heavy commodities. Light cars have been tried by a number of roads but the saving in the cost of operation was not enough to offset the additional expense for repairs. Mr. Ford will indeed be a benefactor if he can show the railroads how to make a car light in weight without sacrificing strength or durability. Mr. Ford's new design of car axle should furnish a good test for his theories. It would seem that an appreciable saving in weight could only be obtained at the expense of added complication. If a lighter design can be developed that will not be more expensive to build or maintain than the present type, one of the oldest M.C.B. standards will have to be discarded.

In the mind of the general public the name of Henry Ford is a synonym for efficiency in business. On the other hand, rightly or wrongly, there is a general belief that the methods in use by the railroads are very inefficient. It is not unusual to hear the statement that any competent business man could operate the railroads more economically than the men who are now in charge. Perhaps Mr. Ford will prove that there is some foundation for this belief, but it is more probable that when his ideas are thoroughly tried out, they will vindicate the judgment of the men who have made the mechanical equipment of the railroads what it is today.

The Reintroduction of Piecework

Now that the Labor Board has modified the working rules for shop employees to provide for payment on a piecework basis, it is probable that many roads on which this system was in effect prior to federal control will again adopt it. The present wage scale is certainly deficient in failing to reward the efficient and diligent workman for his high production. The most important advantage of piecework lies in the fact that it provides a powerful incentive for personal efficiency by basing payment on results.

The flexible wage scale which piece work affords is a direct benefit to the worker but it also has very real advantages for the employer. The best mechanics, realizing that their services are worth more than the usual rate paid to the craft, almost always seek employment where their special output receives an extra reward. Therefore a flat rate would tend to drive out of railroad work the high-grade men who combine ability and ambition. Men of this type the railroads cannot afford to lose.

Probably piecework would not be justified solely for the purpose of retaining in the service men who might otherwise seek work elsewhere. But if the system is properly applied, it should bring about a considerable increase both in individual output and in the total production of the shop. The workers and the management are jointly responsible for this increase and they should share in the benefits. The company can reasonably expect a decrease in unit costs and the employee should receive a substantial increase in wages.

There has been just criticism of piecework in the past practically all of which was based fundamentally on the failure to divide the increased earnings due to piecework fairly between employer and employee. If piecework is to be a success under present conditions, the mistakes of the past must be avoided. Piecework rates should be established on the basis of a careful study of the job. Having set the price, the management should make it understood that so long as the method and the equipment are not changed, the price will not be altered except to make it conform to changes in the hourly wage scales. The practice of reducing rates if employees earn much over the average has a pernicious effect in arousing distrust of the piecework system and puts a check on production. The employer should recognize that high individual output decreases overhead and therefore the high-grade workman is worth all he can earn. The possibilities of piecework cannot be realized if it is not established on a basis of mutual confidence and fair play. Where both parties strive to make the system a success, there is no doubt that the employer and employee both can secure results that will amply justify the substitution of payment by results for the flat hourly rate.

Order vs. Disorder

Some men have a natural tendency to be systematic and orderly in all their work; others are just the reverse and never seem satisfied until everything is congested, both work and working implements being hopelessly mixed together regardless of the order in which they will be needed or used. Both extremes of order and disorder, together with all intermediate stages, may be found in railroad repair shops, and it is the purpose of this editorial to consider briefly the relation of orderliness to shop output, stating first our conclusion and then the reasons for it.

As with most problems in life, so with the question of orderly work; fortunate is the man or shop able to strike a "happy medium." It is perfectly possible to imagine a railroad shop where so much time is spent picking up and cleaning up and piling material to a hair line that practically no time is left for actual repair work. On the other hand, probably every reader has at some time or other visited a shop where the reverse is true. Machine tools and equipment are scattered everywhere, without regard to the sequence of operations. Unfinished machine parts, castings, flue racks, driving wheels, etc., are dropped on the floor wherever there is room, and it is difficult to get from one department to another on foot, to say nothing of operating trucks for the transportation of material. Congestion of this sort causes a serious delay in repairing and replacing locomotive and car parts; the additional manual labor involved in moving parts from place to place is costly; in some cases, material lying around on the floor is damaged and the repair work must be done over; and finally, it is always dangerous for men to work in a badly congested shop.

As a rule, it is more common to find a shop suffering from too little rather than too much order. The emphasis should be placed on order. In a particular case, where it is desired to make a shop more orderly, the question may be raised, how can this be accomplished. In the first place, the idea must be "sold" to the shop superintendent and foremen; in almost every well ordered shop it will be found that some one in authority makes a hobby of the subject. The second step is to group machines used in repairing each essential part, arranging these machines in the order of individual operations, thus eliminating back travel of material and parts. A third preparatory step is the establishment, and marking off, of wide passageways between machine groups and departments, these passageways to be kept clear at all times of machine parts, castings or material of any kind.

After obtaining the proper physical equipment and layout of machine tools, an effective shop schedule system should be installed, (1) to show the order in which each important locomotive or car part is needed, (2) to keep all parts moving, and (3) to show the reasons for delay, whether a weak department, lack of men, inability to get material or what not. But the shop schedule is too important a subject to be more than mentioned in the limited space available for this editorial. It will be discussed more in detail later.

As a final suggestion, it will undoubtedly pay in any medium sized shop to have one man do nothing but pick up material carelessly thrown around and clean out *all corners*. Experience has shown that this practice saves a large amount of material (often worth more than enough to pay for the man's wages) and, in addition, helps materially in increasing the morale of the workmen. Who is it that does not like to see a clean, orderly shop with everything moving in accordance with a well defined plan; storage platforms substantially made and arranged for the prompt locating of material; a place for everything and everything in its place? The general idea of efficiency and effectiveness obtained in an orderly shop is not false and the effort and pains required to secure order are rewarded by a proportionate increase in shop output.

Progress in Boiler Design

In designing locomotive boilers it was formerly the practice to provide a grate large enough to burn the amount of coal theoretically required and then crowd into the shell of the boiler as much heating surface as possible. In recent years the high evaporative value of firebox heating surface has been demonstrated and the use of combustion chambers has become quite general. The improved performance due to the combustion chambers is clearly shown in the test of two locomotives of the same type and approximately equal weight. At the same rate of combustion the boiler with the combustion chamber gave approximately 20 per cent greater evaporation per pound of coal than the boiler without.

The exact length of tubes and combustion chamber to give the best results is difficult to determine. For example it was found in one case that a comparatively slight change in the design of the boiler, shortening the combustion chamber 15 in. and lengthening the tubes a like amount resulted in an increase in the evaporation per pound of coal ranging from 6.6 to 9.8 per cent.

The volume of the firebox and the gas area through the tubes are now recognized as important factors in determining the maximum rates of combustion and evaporation. Methods of improving the circulation of the water are coming into prominence and attention is being given to increased area of steam relieving service to avoid generating wet steam at high rates of evaporation. Great as the progress in boiler design has been there is still need for further investigation to enable engineers to formulate general rules for the most economical proportions of boilers.

Does Gas Cutting Always Pay?

Everyone concedes the important part played by the oxy-acetylene cutting torch, both in industrial and railroad shops, and should any doubts be entertained they will vanish on even a superficial inspection of the work done with it. Everywhere one goes parts are being manufactured, repaired, or reclaimed by the use of the cutting torch and at a saving of man hours, machine hours and physical effort.

One important point, however, should not be overlooked and that is the cost both for gas and labor. Recent tests have shown that a large proportion of the cost of gas cutting operations is for oxygen and that it costs anywhere from two dollars to five dollars an hour to operate a torch, depending upon whether light rivets or heavy steel sections are being cut. Obviously with this cost of operation, cutting torches must not be used indiscriminately either for cutting material of less value than the gas used, or material which can be more efficiently cut by machine. Moreover, there is a tendency for workmen to take every small cutting job to the oxy-acetylene table even when a slight physical effort would accomplish the same result at a lesser cost.

The possibility of cutting with the electric arc using a carbon electrode also should not be forgotten and, while comparative figures are not available undoubtedly there are occasions when cutting with the electric arc is more desirable from the standpoint of economy than cutting with the gas torch. This is particularly true when an ample supply of relatively cheap electric power is at hand.

Another method to be considered is cutting by mechanically operated gas torches; this is the subject of an article in this issue. The Radiagraph and similar types of machines for gas cutting on straight lines, circles and curves have demonstrated their value in cutting sheet metal and blanking out machine parts. They are used in industrial establishments and have been introduced to a certain extent in railroad shops. For steel car work, boiler shop work and certain operations on locomotive machine parts the mechanically operated cutting torch is an efficient tool and will save much money, particularly where conditions are such that the torch can be slowed down to give a smooth finished cut, obviating the need of subsequent machining.

The questions of what cutting apparatus to use, what material to cut and what not to cut can be solved only by an accurate knowledge of relative costs. In view of the possibilities of waste or economy, it would seem wise to have gas cutting operations under the direction of one man who will keep a record of labor, material and gas costs, thus being able to recommend in any particular case the most effective and economical cutting practice.

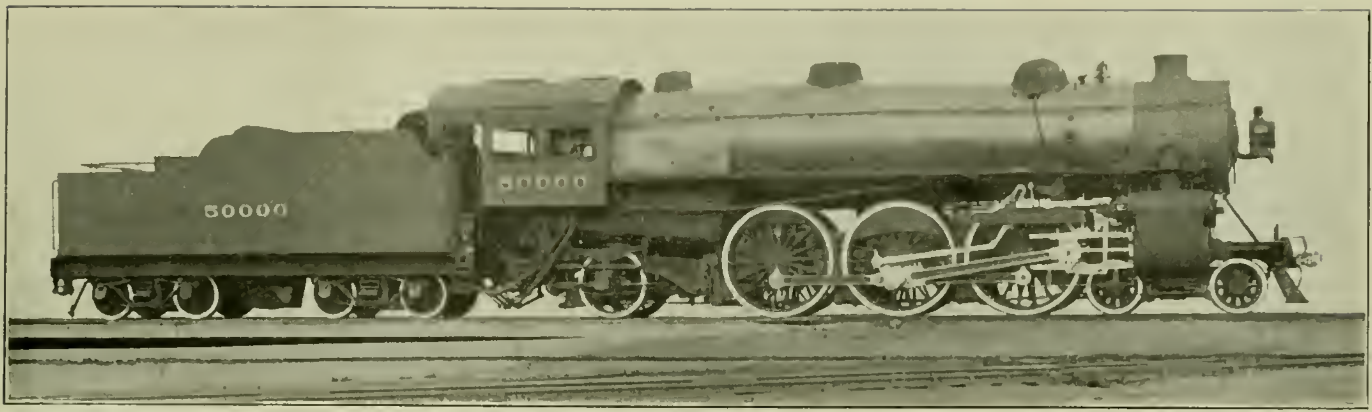
NEW BOOKS

Master Boiler Makers' Association Committee Reports. Edited by Harry D. Vought, secretary, 26 Cortlandt street, New York. 68 pages, 6 in. by 9 in. Bound in cloth.

This book contains the reports of committees on subjects prepared and filed for the thirteenth annual convention of the Master Boiler Makers' Association which was scheduled to be held at St. Louis May 23 to 26, 1921, but which was cancelled on account of the business conditions on the railroads. In place of the regular Official Proceedings it was decided by the Executive Committee to issue the committee reports which cover the following subjects:—Investigation of Autogenous Welding; Methods of Welding Safe Ends on Locomotive Tubes; Better Type of Crown Stay for Different Classes of Locomotives; Prevention of Deterioration of Fireboxes Behind Grate Bars; Causes of Boiler Shell Cracking Through Girth Seam Rivet Holes; Ways of Overcoming or Prolonging Time of Rupture; Best Type of Side Sheet; Oxy-Acetylene Welding; Electric Welding; and Advantages and Disadvantages of Treated Water.

Railroad Shop Practice. By Frank A. Stanley. 331 pages, 5 in. by 9 in. Bound in cloth. Published by McGraw Hill Book Company, New York.

The purpose of this book as outlined in the preface is to show typical methods and appliances adapted to the work of various repair shops. It contains 23 chapters, covering in a general way practically all phases of locomotive repair shop operation. Data for the preparation of the book was secured from railroads in various parts of the country and the methods shown, therefore, are not simply local. The description of methods is written primarily from the standpoint of general machine practice and in many cases the author shows lack of familiarity with general railroad shop methods. The author has given little consideration to the problem of repairs in its general aspect, but has treated each operation as practically unrelated to other work. Consequently, the book is more in the nature of a collection of shop kinks than a treatise on general shop practice. A very large portion of the entire book is devoted to machine shop practice, although short sections dealing with blacksmith shop, boiler shop and car department practice are included. Some of the methods described are probably the very best practice in their respective lines, but other methods included would be classed as obsolete in the majority of shops. The value of the book would have been increased if greater care had been taken to give each important division of railway shop work the attention which its relative importance would warrant and if more discrimination had been used in selecting the examples of shop practice described in the work.



Experimental Pacific Type No. 50000, Which Established New Records for Power per Unit of Weight

Avoidable Waste in Locomotive Operation as Affected by Design*

BY JAMES PARTINGTON
Estimating Engineer, American Locomotive Company

IT SEEMS advisable to consider this subject from the constructive standpoint of indicating what constitutes good design as demonstrated by locomotives in actual service, rather than to attempt to point out the defects in locomotives which do not show maximum efficiency. If any power plant or engine is not properly proportioned for the work it has to do, the most expert skill in operation can reduce only in part the waste resulting from having such equipment in service.

First, considering the design of steam locomotives from the standpoint of new equipment, when a railroad company is in the market for new locomotives its requirements may be met sometimes by duplicating locomotives in service on their road, but adding newly developed attachments which make for increased efficiency and economy. More frequently, however, it will be found that increased traffic, change from wooden to steel cars, improvement in track, roadbed and bridges, etc., will justify and make advisable the adoption of locomotives of a larger and more powerful type.

Then careful consideration must be given to service requirements—maximum loads to be hauled, capacity of cars, approximate proportion of loaded to empty cars per train, grades, curves, running time over divisions, maximum allowable load per axle, location of coal chutes and water tanks, clearances, conditions under which trains must be started, and any other special requirements of the service.

Having determined the drawbar pull necessary, it remains to design a locomotive that will have the following efficiency requirements:

1 A drawbar horsepower for the minimum amount of fuel.
2 A drawbar horsepower for the minimum amount of weight of locomotive and tender.
3 A drawbar horsepower for the minimum cost of repairs.

Fuel Economy

As standard practice in modern locomotives, a sectional brick arch in the firebox and a fire-tube superheater should be applied as a means of saving fuel in any class of service. A sectional brick arch is low in first cost, easily applied and easily renewed. It usually accomplishes a fuel saving of from 10 to 12 per cent in coal-burning engines, and about 5 per cent in oil-burning engines.

The very general use of superheaters has gradually brought about improved conditions of cylinder lubrication which now make it possible and desirable for the greatest economy to use a high degree of superheat, 250 to 300 deg. F. now being considered the best practice. A saving of 25 to 30 per cent can be obtained.

The use of feedwater heaters will further conserve fuel, and these are now in general use in continental Europe and are gradually being applied to locomotives in the United States. The saving that can be realized is as much as 12 per cent. The initial cost is considerable, but the effect of the feedwater heater in operation, aside from fuel economy, will be to help reduce other boiler-maintenance charges.

The general proportions of the boiler should also receive careful consideration. For the best results with bituminous coal, the length of the boiler tubes should be approximately within the following limits:

Size of tube, in.	Distance over tube sheet
2	18 ft. 0 in. to 19 ft. 6 in.
2¼	22 ft. 6 in. to 24 ft. 6 in.
2½	28 ft. 0 in. to 30 ft. 0 in.

For many designs of locomotives, a combustion chamber can be provided, and this will help further in the economical production of steam. A generous steam space should be provided, and the throttle designed and located to secure dry steam. The evaporative capacity of the boiler should be as nearly 100 per cent of the maximum steam requirements of the cylinders as the type of locomotive will permit. Based on 100-per cent boiler, the grate area should be sufficient to prevent the maximum coal consumption per sq. ft. of grate per hour from exceeding, for bituminous coal, 120 lb., and for anthracite coal, 55 to 70 lb., depending on size.

When the total coal consumption exceeds 6000 lb. per hr., it is generally necessary to apply an automatic stoker. These have now been so adapted to locomotive requirements that a properly designed stoker will show economy over hand firing, aside from the necessity of its use on account of the coal consumption being greater than the physical capacity of one fireman if the boiler were hand-fired.

The arrangement of deflector plates and netting in the

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*A paper to be presented at the meeting of the Railroad Division of the American Society of Mechanical Engineers, New York, December 9.

smoke-box should be carefully adapted to the fuel and combustion conditions, to provide minimum fuel waste and minimum back pressure in the cylinder-exhaust passages with proper provision against fire hazards which might obtain by the throwing of sparks.

The boiler being designed to produce steam at a minimum cost, it is now necessary to design the engine to use this steam with maximum economy.

The cylinder proportions and diameter of the drivers should be such as will develop maximum horsepower at the ruling speeds for train movements. The greatest horsepower of locomotive cylinders will usually be developed within a piston speed ranging from 700 to 1000 ft. per min. Therefore, if other traffic conditions will permit, the operation of trains within these limits should show the greatest operating economy.

Minimum Weight of Motive-Power Equipment

The weight on the locomotive drivers gives an engine friction, independent of other factors, of 22 lb. per ton. The desirability of avoiding excess weight on the drivers from this standpoint alone is therefore readily apparent. When the type of engine will permit, this weight should not exceed what is necessary to give a satisfactory factor of adhesion; this is usually 4¼ times the maximum tractive power. All weight in excess of this and all other excess weight and excess tender weight should be eliminated, as far as this can be done without detriment to the design of engine and tender. This applies with particular force to the machinery parts of the engine, especially those parts which affect the counterbalance. All saving in weight in these parts usually produces a similar saving in counterbalance weights and a reduction in the dynamic augment, which is very desirable from the standpoint of track and roadbed maintenance.

The use of special materials to keep down weight is often amply justified if repair parts can be obtained promptly when required. This, in the past, has often been the cause of delay, but it can be guarded against by carrying a few spare parts in stock ready for renewals. High-tensile alloy steel can frequently be used to advantage for driving axles, crank pins, main and side rods, piston rods, etc.

Occasional steep grades or hard starting conditions at stations may cut down the hauling capacity of locomotives over a division to a serious extent. In such cases, the utilization of the weight on trailer trucks for additional tractive power in starting and at slow speeds may increase the capacity of the locomotive from 10 to 25 per cent, depending on the number of driving wheels and working pressure. It has been demonstrated that a separate steam engine or booster geared to the trailing axle will give this additional traction, and that it can be cut in or cut out very satisfactorily as occasion may require.

This is an item in economical operation worthy of consideration where hauling capacity is restricted by such limitations, and the use of an independent booster may often permit the satisfactory operation of considerably lighter locomotives for service of this character.

Within the limits of this paper, only the major features of design can be outlined briefly, and only such devices as have been carefully tried out and are in successful operation are cited. The writer believes the savings mentioned are well within what may be obtained in practice.

Many other improvements promising further economy in the generation and use of power in the steam locomotive are contemplated and are now in the experimental stage, but these do not properly come under the scope of our subject as here treated.

Cost of Repairs

It has been pointed out that locomotives and tenders should be designed to produce the required drawbar horsepower with as little excess weight as possible. In this connection, however, due consideration must be given to the question of repairs.

The design of boilers from the standpoint of weight is practically fixed by existing boiler regulations, which provide that locomotive boilers must be operated with a factor of safety of not less than four. Practically all boilers at the present time are designed with a factor of safety of 4½, which leaves a comfortable margin between this and the minimum allowable operating factor.

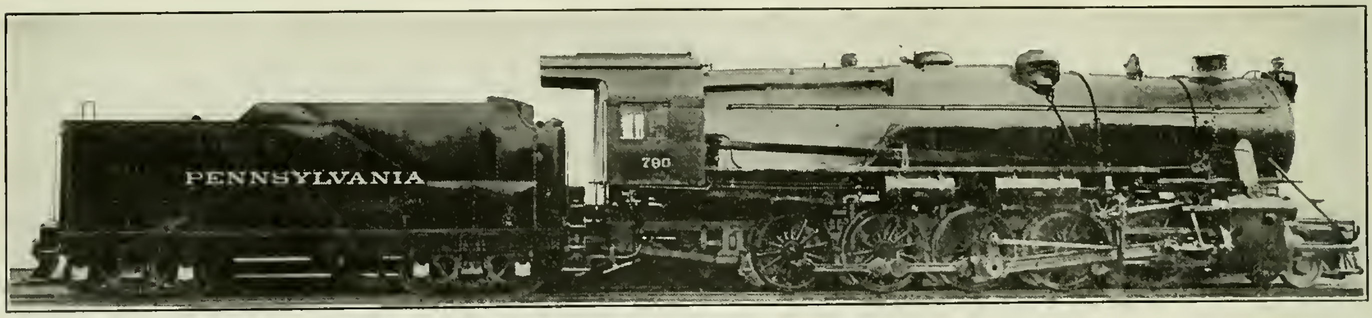
The maximum stresses in other parts of the locomotive must also be carefully considered, and the parts must be designed to keep these stresses within limits which will eliminate costly failures in service.

Aside from the consideration of stresses, much repair cost can be avoided by adopting designs which reduce the number of parts, as far as reasonably may be, especially where these parts must have bolted connections. Here, however, care must be taken to avoid construction which cannot readily be removed for repairs or renewals or repaired in place with reasonable facility.

Many roads today are giving a great deal of thought to locomotive design along these lines, having especially in mind the desirability of making the engine parts accessible for oiling and inspection; easily removable with proper shop facilities; of the minimum number of pieces and interchangeable with equipment now in service.

The repair-shop facilities must, of course, be kept abreast of the requirements; *i.e.*, as new and larger locomotives are put in service, turntables, cranes, machine tools, etc. must be of sufficient capacity to handle the larger equipment economically.

The repairs of locomotives can often be facilitated and the necessary shop equipment kept down to the minimum by securing from the locomotive builder many parts which he is able to turn out more accurately and more economically than the average railroad shop would be equipped to do. Such parts include: flanged sheets for boiler repairs; flexible and ordinary staybolts; finished bolts and nuts; drop forgings; packing rings for pistons and piston valves and

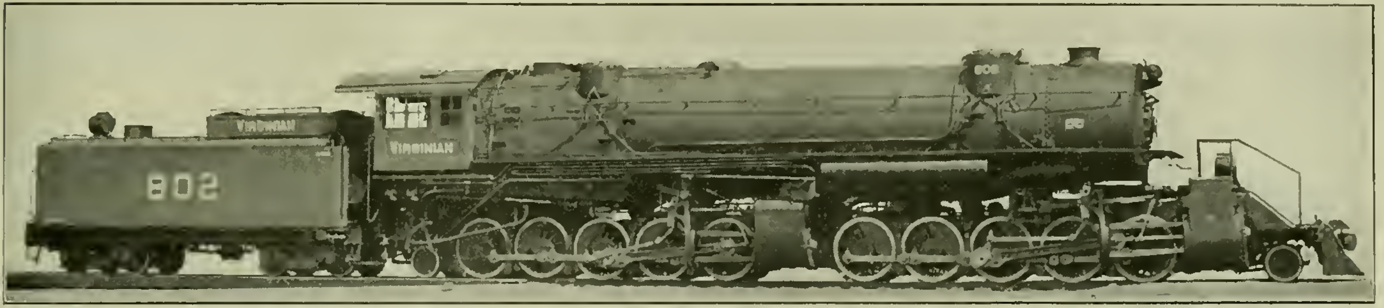


Pennsylvania Decapod With Short Maximum Cut-Off, Which Shows Remarkable Economy Over a Wide Range special equipment which requires special tools for its production.

Without attempting to pursue further the design of new locomotives it may be remarked that a study of the special conditions of individual railroads is necessary to secure equipment best suited to the needs of each.

Old Motive-Power Equipment

Much waste in locomotive operation can be avoided by making a careful survey of present motive-power equipment which is not giving as economical or efficient service as could be obtained if the engines were modernized. This applies particularly to locomotives where the service conditions demand more power than the present equipment can economically produce. All the suggestions made in regard to the design of new equipment are applicable to a greater or less degree to old equipment, providing the old equipment is not meeting the demands of the service from a power standpoint, or is not furnishing this power economically.


Virginian 2-10-10-2 Type, the Most Powerful Locomotive in the World

In making a survey of this character care should be taken to determine accurately whether the old equipment will warrant the additional cost of changes and betterments necessary to convert it into up-to-date power. This can be decided by taking the number of years the engines will be retained in service and the increased net return or saving for this period as against the cost involved for changes, interest on the additional investment, increased maintenance, etc.

A comparison should also be made with the results that could be realized by the purchase of new equipment best adapted for the service, as against the cost of contemplated changes in the old equipment. If these comparisons show a saving in favor of modernizing the old equipment or the purchase of new equipment, every month that the engines are kept in service without doing this will result in a loss that is not recoverable.

A few concrete examples of what has been accomplished in service by locomotives designed to yield maximum efficiency may be of advantage. Notable designs, for which data is available, are as follows:

Pacific type passenger locomotive No. 50000 built by the American Locomotive Company; Decapod type freight locomotive, Class I1s, built by the Pennsylvania Railroad and heavy Mallet special service locomotive built for the Virginian by the American Locomotive Company.

American Locomotive Company Engine No. 50000

Locomotive 50000 was built by the American Locomotive Company in 1910. It was designed and constructed at the builder's expense to demonstrate the maximum tractive power with adequate boiler capacity that could be obtained while keeping the adhesive weight below 60,000 lb. per driving axle.

Untrammeled by any outside specifications or the necessity of conforming to any railroad's existing standards, the builders had a free hand to embody in this design their ideas of the best engineering practice. To accomplish the purpose of the design—the maximum capacity per pound of weight—the largest boiler capacity within the predetermined wheel loads was the essential feature.

This end was obtained by eliminating every pound of weight in all the parts that was not necessary to strength and durability, utilizing the weight thus saved to provide a larger boiler, and by increasing the capacity of the boiler thus secured by combining in one design the most approved fuel saving devices to obtain the utmost economy in boiler and cylinder performance.

Many of the large Pacific type locomotives with drivers 75 in. in diameter and over in operation today greatly exceed locomotive 50000 in total weight.

An average of all of the important engines of this type including locomotive 50000 shows approximately 1,000 lb. less tractive power with an increase of 17,400 lb. in weight with the very slight advantage of only 1½ per cent in boiler capacity. (See table appended).

Locomotive 50000 delivers one cylinder horse power for every 110.8 lb. of weight and one boiler horse power for every 120.3 lb. of weight.

In actual tests it developed:

An average rate of 2.21 lb. of coal per i.h.p. hour.

A low rate on one test of 2.12 lb. of coal per i.h.p. hour.

An average rate of 16.85 lb. of steam per i.h.p. hour.

A low rate on one test of 16.5 lb. of steam per i.h.p. hour.

A maximum indicated horse power of 2,216 or one horse power for every 121.4 lb. of weight.

The thought occurred that possibly 50000 was built too light and that later on, in order to keep the engine in service, many of the parts might require strengthening.

Locomotive 50000 was purchased by the Erie Railroad and numbered 2509. Wm. Schlafge, Mechanical Manager of the Erie, states that since the locomotive was received it has been necessary to make very few changes. The guide yoke was reinforced on account of working. Guide yoke blocks were also made solid on the guide yokes. The trailer spring sliding block was changed to the same type as used on the railroad's K-4 Pacific type locomotives. No other changes or alterations have been made. Yet from the time this locomotive was placed in service on the Erie up to March 1, 1920, it had made a total mileage of 351,800.

Ten years of service coupled with 350,000 miles of running demonstrate the strength of the design and the figures given indicate remarkable performance.

Pennsylvania Railroad Class I 1s

While the design of engine 50000 represents the best practice of the present day as measured by the economical operation of passenger locomotives, the development of heavy freight power involves the consideration of other factors that materially affect the design. In 1915 the Pennsylvania Railroad found that for the economical operation of their line a tractive power about 25 per cent in excess of the Mikados then in use was desirable. In working on the design for such an engine, an attempt was made to obtain better economy in performance by a radical departure in cylinder proportions. The accepted practice in proportioning cylinders is to arrange for a cut off of nearly 90 per cent of the stroke, so that the starting torque may be as uniform as possible.

As the adhesive weight limits the cylinder diameter if excessive slipping is to be avoided, it is obvious that on long grades, where the maximum tractive effort is required, the long cut offs use steam in a most uneconomical manner. As the Pennsylvania has several such long grades on its line, the new design adopted involved a limitation of the cut off to about 50 per cent in place of 90 per cent and an increase in the cylinder diameter to give sufficient torque at this cut off to fully utilize the adhesive weight. The expected increase in economy of coal and water due to the shorter cut off has been fully realized. Not only has the engine shown remarkable efficiency, but the economy under wide ranges of load is especially remarkable.

We are fortunate in having available a very complete test of this engine, made on the testing plant at Altoona. (Bulletin 31, P. R. R. Testing Plant 1919, copyrighted). This test shows a water rate of 15.4 lb. per i.h.p. hour with a total i.h.p. of 3,080 at 40 per cent cut off and a coal consumption 2.9 lb. The lowest coal consumption recorded is 2.00 lb. per i.h.p. hour, obtained at an output of 1,777 i.h.p. and a cut off of 30 per cent.

The thermal efficiency of the locomotive is also high and well sustained over a large range, a maximum of 8.1 per cent being attained at an output of 1,777 i.h.p., and the range being from 6.1 per cent at 776 i.h.p. to 5.3 per cent at 3,486 i.h.p. with an average of over 7 per cent for the usual operating conditions.

The highest drawbar pull recorded in these tests is 76,211 lb. at a speed of 7.4 m.p.h., but in road service a pull of 80,640 lb. has been recorded at 7.2 m.p.h. The indicated tractive effort plotted from a card taken at 7.4 miles per hour at 55 per cent cut off is slightly over 90,000 lb.

This design gives a calculated figure of 88.9 lb. per cylinder horse power, the lowest on record. During the tests an indicated horse power of 3,486 was developed, giving a weight of 106.2 lb. per horse power. The weight per boiler horse power does not compare as favorably, however, as it is 145.4 lb. The Belpaire firebox contributes materially to this excess.

Virginian 2-10-10-2 Type Locomotives

The large 2-10-10-2 Mallet engines for the Virginian were designed to meet their unique conditions. This road was built as an outlet to certain bituminous coal fields of West Virginia. Practically the entire revenue business is confined to hauling coal to the shipping docks at Sewall's Point, the west-bound revenue freight being negligible in amount, as only one town of any importance, Roanoke, is located on the line. As the development of the coal fields proceeded the tonnage to be handled increased rapidly, rising from 2,141,009 in 1911 to 7,621,555 in 1920, and in order to handle the business at a profit the maximum attainable capacity in motive power was demanded. Having fixed on 100 cars as the maximum number that could safely be handled in a single train, the car capacity increased to 120 tons, it was estimated that a locomotive of 147,000 lb. tractive power would be needed to haul the train from Princeton to tidewater, a helper being used for a grade of .6 per cent ten miles long over the Alleghenies. The 2-10-10-2 Mallets were designed to meet these conditions and their operation has been very successful. They have handled trains of 16,000 tons on a .2 per cent grade with the lowest consumption of coal per ton mile ever recorded. Unfortunately, accurate tests of coal and water per dynamometer horse power are not available owing to the fact that there is no dynamometer of adequate capacity to be had at present. However, on May

LARGE PACIFIC TYPE LOCOMOTIVES NOW IN OPERATION IN THE UNITED STATES

Engine	50,000												Average
Cylinders	27 in. by 28 in.	27 in. by 28 in.	25 in. by 28 in.	25 in. by 30 in.	27 in. by 28 in.	26 in. by 28 in.	26 in. by 28 in.	23½ in. by 26 in.	26 in. by 28 in.	25 in. by 28 in.	25 in. by 28 in.	25 in. by 28 in.	25.6 in. by 28 in.
Drivers—dia.	79	80	79	75	77	79	75	79	75	77	80	75	77.5
Boiler—dia.	76⅜	78½	76¾	79⅞	75 1/16	78	78 9/16	70⅝	76	74	72	69	....
Pressure	185	205	210	200	185	210	200	200	190	200	200	185	197.5
Firebox, length	114⅛	126	126	111⅛	114 1/16	126⅛	114⅝	108⅛	110	120⅝	126¼	108⅛	....
Firebox, width	75¼	89	108¼	84⅜	84	108¼	84¼	75¼	72	84	108¼	70¼	....
Tube, length	22-0	19-0	17-3	18-6	22-0	19-0	20-6	21-6	20-0	22-0	19-0	20-0	....
Wheel base driving.	14-0	13-10	14-0	13-2	14-0	13-10	13-0	14-0	13-0	13-4	13-10	13-6	....
Wheel base engine.	35-7	36-6	36-0	34-9	36-2	35-8	34-11	36-6	34-4	35-8	35-7	34-9	....
Weight on drivers..	172,500	201,800	192,500	181,500	178,000	181,400	194,000	184,500	169,500	165,000	176.900	168,500	180,500
Weight of engine..	269,000	308,900	302,000	299,000	295,000	291,400	287,000	282,000	280,000	279,500	273.600	269,000	286.400
Heat. surf. tubes and flues	3,808	3,746.8	2,830	3,232	3,534.7	3,454	3,939	3,193	3,380	3,720.9	2,644	2,970	....
Heat. surf. firebox.	248	288.6	351	297.6	239.8	303	259.6	231	240	266.4	282	230	....
Heat. surf. total...	4,056	4,035.4	3,181	3,529.6	3,774.5	3,757	4,198.6	3,424	3.620	3.987.3	2,926	3,200	3,640.8
Superheating surface	897	1,154	645	803	962	816	970	838	830	783.5	652	778	....
Grate area	59.8	70.0	95.0	65.0	66.5	94.8	67	56.5	55	70.4	94.5	52.7	61.6* 70.6
Tractive power	40,600	41,845	39,500	42,600	41,700	42,770	42,900	30,900	40.700	38,600	37,200	36,700	39,670
Cyl. h.p.	2,427	2,690	2,365	2,252	2,427	2.556	2,434	1,990	2,312	2,252	2,252	2,083	2,336
Boiler h.p.	2,235	2,467	2,244	2,282	2,104	2,311	2,398	1,958	2,112	2.267	1,950	1,869	2,186
Weight per cyl. h.p.	110.8	114.8	127.7	132.8	121.5	114.0	117.9	141.7	121.1	124.1	121.5	129.1	122.8
Weight per boiler h.p.	120.3	125.2	134.6	131.4	140.2	126.1	119.7	144.0	132.6	123 3	140.3	143.9	131.8
Boiler percentage...	92.0	91.7	95.0	101.0	86.7	90.5	98.5	98.2	91.5	109.5	86.8	90.0	93.5

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*Is an average of the soft coal burning engine only. The figure 70.6 is the average for all the engines, including the hard coal burners.

25, a train of 15,725 tons behind the tender was hauled from Princeton to Roanoke at a rate of 26.9 lb. of coal per 1,000 ton miles, and on May 27 a 75 car train of 12,070 tons showed the same figure for coal per thousand ton miles.

One of these engines has hauled a train of 110 cars weighing 17,250 tons from Victoria to Sewall's Point, which is believed to be the heaviest train ever handled by one engine. The ruling adverse grade was .2 per cent.

The principal dimensions of the three locomotives cited and a comparison of the horse power characteristics—calculated by the American Locomotive Company's method—are embodied in the following table:

Modern Maximum Efficiency Locomotives

Road	No. 50000 Erie	Virginian	Pennsylvania
Type	4-6-2	2-10-10-2	2-10-0
Fuel	Bituminous coal	Bituminous coal	Bituminous coal
Boiler, type	Conical connection	Extended wagon top	Conical connection
Boiler, diameter	76¼ in.-87 in.	105½-118½ in.	87-90½ in.
Weight on drivers, lb.	172,500	617,000	342,050
Weight on truck, lb.	49,000	32,000	29,750
Weight on trailer, lb.	47,000	35,000	....
Weight, total, lb.	269,000	684,000	371,800
Driving wheel diam.	79 in.	56 in.	62 in.
Cylinders	27 in. by 28 in.	30 in. and 48 in. by 32 in.	30½ in. by 32 in.
Boiler pressure, lb. per sq. in.	185	215	250
Tractive power, lb.	40,600	147,200	90,000
Factor of adhesion	4.25	4.08	3.80
Cylinder horse power.	2,427	5,040	4,182
Grate, length and width.	114 in. by 75¼ in.	144 in. by 108¼ in.	126 in. by 80 in.
Grate area, sq. ft.	59.7	108.7	70.01
Tubes, number	207	381	244
Tubes, length	22 ft. 0 in.	25 ft. 0 in.	19 ft. 1 in.
Tubes, spacing	¾ in.	⅞ in.	⅝ in.
Tubes, thickness	No. 11 B. W. G.	No. 11 B. W. G.	.125
Tubes, diameter	2¼ in.	2¼ in.	2¼ in.
Flues, number	36	70	48
Flues, diameter	5½ in.	5½ in.	5½ in.
Flues, thickness	3/16 in.	No. 9 B.W.G.	.18
Combustion chamber—length.	None	36 in.	42 in.
Brick arch	Security	Gaines	Security
Heating surface—firebox, sq. ft.	248	532	290
Heating surface tubes—water side, sq. ft.	2,672	5,592	2,731
Heating surface flues—water side, sq. ft.	1,136	2,511	1,313
Heating surface total, sq. ft.	4,056	8,635	4,334
Boiler horse power	2,250	4,800	2,553
Steam rate, lb. per hp. hour.	20.8	19.7	20.8
Coal rate, lb. per hp. hour.	3.25	3.1	3.25
Superheater, number of units.	36	70	42
Superheater, diameter	1½ in.	1½ in.	1½ in.
Superheater, heating surface.	879	2,120	1,418
Tender weight in running order, lb.	161,500	214,300	182,000
Tender capacity coal, tons.	14	12	17½
Tender capacity water, gallons.	8,000	13,000	9,000
Weight of locomotive in lb. per cylinder hp.	110.6	135.7	88.9
Weight of locomotive in lb. per boiler hp.	119.6	142.5	145.4
Best actual performance—			
Steam rate—lb. per hp. hour.	16.5	....	15.4
Coal rate—lb. per hp. hour.	2.12	....	2.0

Drop Pits at Terminals on the South African Railways

BY JOHN D. ROGERS*

The question of drop pit facilities should receive the most careful consideration of American railway motive power officers who at this time are striving to reduce costs of operation and increase the earning capacity of locomotives. The practice of jacking engines for replacing wheels is as obsolete as the tallow candle, yet it still prevails at many terminals. Modern motive power represents enormous invested capital, in addition to which heavy overhead charges are accruing whether the engine is idle or in service. Railway executives should heed the recommendations of their motive power officers for improved facilities, one of the most important of which should be efficient drop pit arrangements. The engineering and motive power departments should co-operate when terminal plans are prepared. There should be no difference of opinion concerning the advantages of drop pits—the principal feature to be considered is the number and arrangement. Drop pits inconveniently placed will often cause delays in the turning of power and compel the roundhouse foreman to "take a chance," the risk of which is too well known for comment here.

It may seem strange to the American railway man to have his attention called to South Africa for an illustration of what has been accomplished in equipping engine terminals with drop pits. The writer had many years' experience in operating roundhouses on some of the important American railways and has in mind many terminals where today the heaviest engines are jacked to a critical height to run out the truck for changing wheels or other repairs; in addition to the excessive loss of time serious damage often results to the engine frame and spring rigging. Practically every terminal on the South African Railways, including those on the outlying districts, is equipped with modern drop pits for truck and driving wheels. These pits are invariably arranged to give the most flexible service for all wheels, including those of the tender. All pits are equipped with an efficient hydraulic jack which is manufactured by the railway company in its shops at Uitenhage.

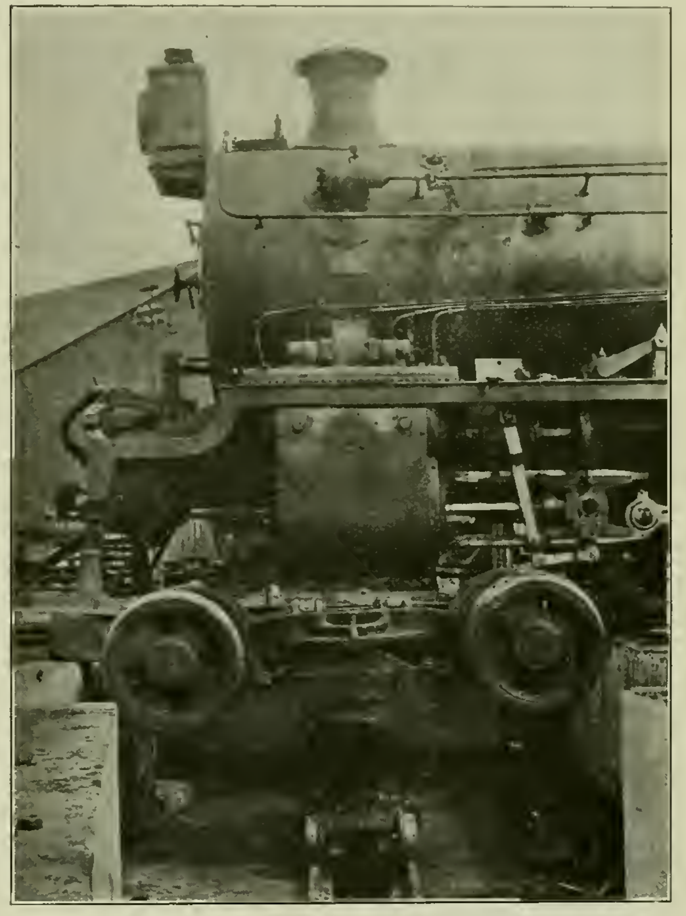

Fig. 1—Engine Truck Drop Pit at Bloemfontein

Pits are always clean and dry; they are constructed of concrete, the walls being whitewashed. The question of drainage has been given most careful attention as many of the pits are in the open and South African rainfalls are ex-

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*Mr. Rogers, who was formerly a mechanical department officer on a number of American railroads and later a captain in the Russian Railway Service Corps, is now technical representative of the Baldwin Locomotive Works at Johannesburg, South Africa.

tremely heavy. With the facilities existing on the South African Railways, the dropping of wheels is considered a routine job, and causes no more concern than packing a piston. Incidentally the number of wheels dropped for hot driving boxes is somewhat in excess of American practice.

In Fig. 1 is shown a drop pit at Bloemfontein, which is one of the most important terminals on the South African railway. The general arrangement is representative of the design for engine and tender trucks. It is 11 ft. wide and permits of reversing the truck without removing it from the pit, a very convenient means of putting sharp flanges behind. When the pit is not in use, the rails are supported by removable columns which fit into a socket in the bottom of the pit. Driving wheels drop pits are always provided, but are seldom used for other wheels, as they are generally blocked by engines undergoing more or less heavy repairs.

The standard drop pit for car wheels is shown in Fig. 2. All yards where wheels are changed have such a pit. The number of tracks served depends on the importance of the terminal. In some cases three or four tracks span a pit. Wheel storage tracks are provided adjacent to those on which the cars are placed.

This concentration of wheel replacement makes the absence of wheels scattered throughout the yards particularly noticeable. Regular wheel gangs are employed; no time is lost in transferring jacks and making a suitable foundation. A small shed, provided with benches and vises together with an assortment of tools, is located near the pit. Spare brasses and boxes are kept on hand, also some packing box "dope."

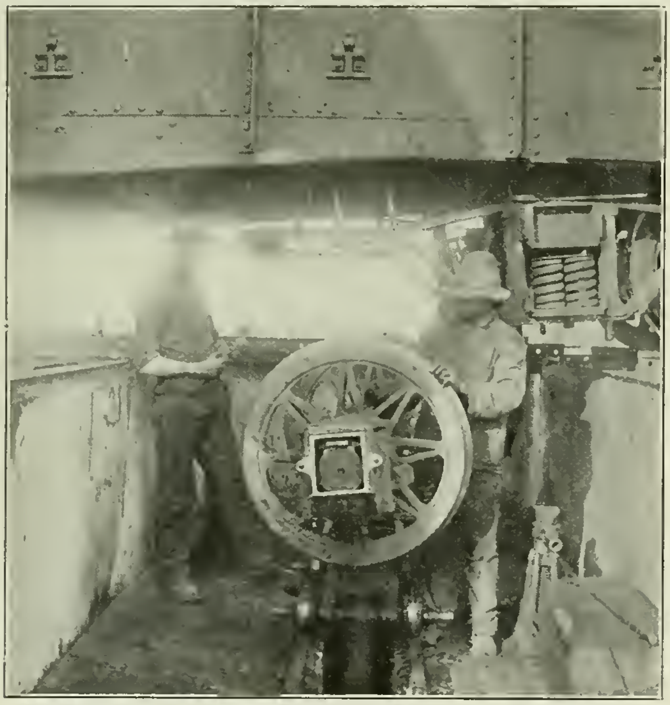


Fig. 2.—In South Africa Drop Pits Are Provided for Changing Wheels on Freight Cars

The platform drop pit shown in Fig 3 is located at Germiston, and was manufactured locally of such material as was available. The six inch vertical screw, *A*, is supported in the carriage by a brass nut. The nut is driven by a reversible air motor directly connected to a worm driving the gear wheel, *B*. The jack is traversed in the pit by the hand wheel, *C*, geared to one of the axles of the carriage.

The minimum time required for raising or lowering the table is approximately two minutes. The lifting capacity is about 20 tons. This is sufficient to raise the end of an empty car high enough to catch the body on jacks, thereby eliminating the time lost in jacking the car. This pit can be used for replacing either a complete truck or a single pair of wheels. Spare trucks of different classes are kept on hand. This is especially advantageous when a truck requires extensive repair, as the car can be returned to service immediately. This feature offers an opportunity to increase car mileage, which must be recognized as the unit of a railway's earning capacity.

Many of the American railways have modern and elaborate facilities for changing wheels on rolling stock. This equipment includes high capacity cranes for lifting cars and trucks. The extensive introduction of such facilities is limited by the fact that in the majority of terminals the first cost is not justified by the saving in operating expenses. It is evident, therefore, that the only alternative is the drop pit.

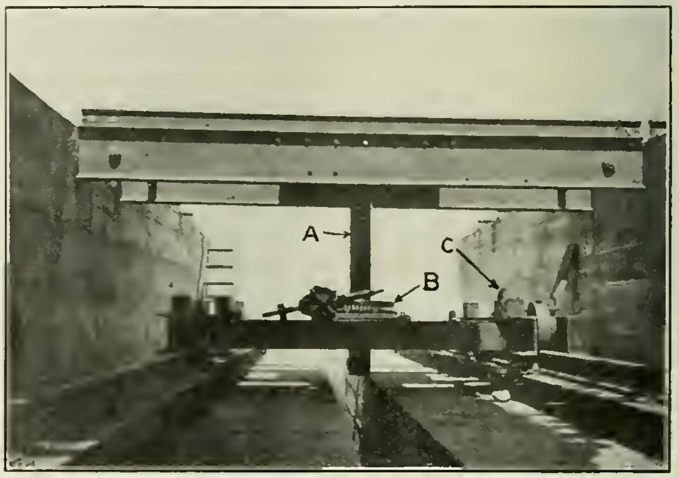


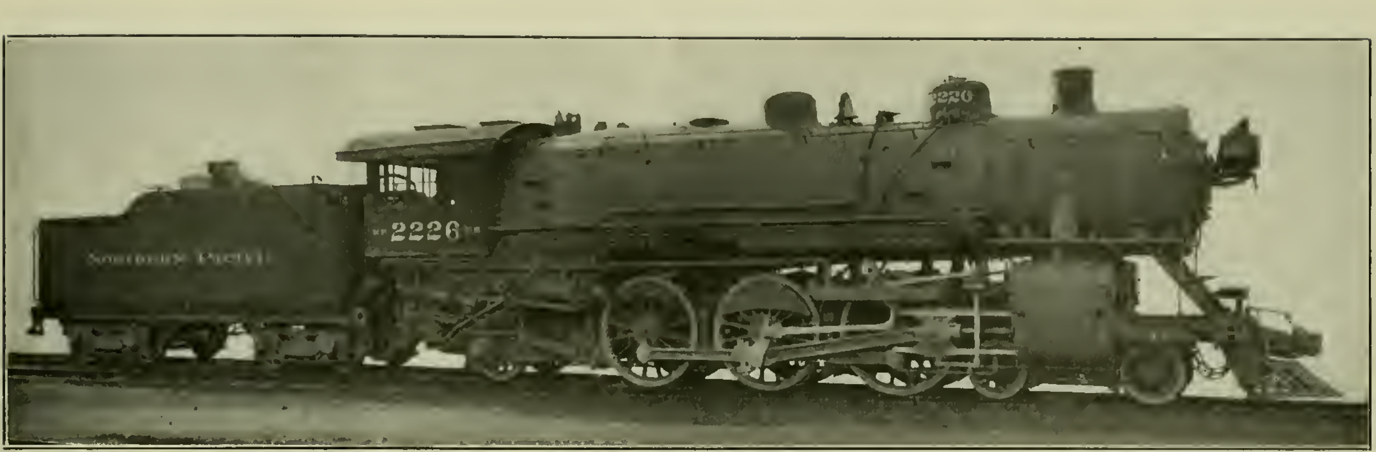
Fig. 3.—A Home-Made Drop Table of 20 Tons Capacity

The Three-Cylinder Locomotive

The three-cylinder type of locomotive has not been received with favor in this country, although it has occasionally been tried. In some of the two-cylinder locomotives now being built the power is limited by the size of the cylinders that can be applied without exceeding the roadway clearance and the three-cylinder type is often suggested.

British railroads have used three-cylinder locomotives to a considerable extent and they are very favorably regarded as is evidenced by these comments from the Railway Gazette:

"For various reasons, based inherently on principle, although largely, of course, dependent upon individual practice and design, the three-cylinder locomotive has proved itself to possess certain decided advantages as compared with equally powerful two-cylinder types. We refer more particularly in this connection to the three-cylinder simple arrangement, such as is used for several different classes of locomotives on leading main lines in this country. First, there is the superior balancing of the engine, which has the effect of adding to the smoothness of its running, and what is equally important reducing the stress upon the track, so that it would appear to be quite possible to utilize a heavier three-cylinder locomotive, having cranks at 120 deg., than a two-cylinder one with cranks at 90 deg. on track where it is necessary to study very carefully the axle loads and total weight of the locomotives employed. Another point is that, owing to the fact of there being six cylinder exhausts to each complete turn of the driving wheels instead of four, a much more even and favorable draught effect is produced upon the fire, thus aiding combustion and as a natural consequence the production of steam. Thus, with its superior torque and more favorable draught conditions, the three-cylinder engine may be expected to come into greater prominence, particularly where the locomotive and track conditions create a difficult problem."



Heavy Pacific Type Handles 12 Passenger Cars or More Over the Rocky Mountains

New Locomotives for the Northern Pacific

Pacific Type for Heavy Fast Service—Mikados, Mallets and Switchers Follow Lines of Earlier Designs

THE Northern Pacific placed one of the largest orders for locomotives given in 1920. This consisted of 20 eight-wheel switchers (0-8-0 type), 20 Pacific (4-6-2 type), 25 Mikado (2-8-2 type) and 6 Mallets (2-8-8-2 type), all of which were built by the American Locomotive Company at the Brooks plant.

Pacific Type

The Pacific type locomotives, railroad Class Q-5, are of a new design developed to meet the need for a heavier fast passenger engine to haul the overload trains. They have been assigned to all divisions between Dilworth, Minn., and Missoula, Mont. The profile on these divisions varies from comparatively level to grades of 2.3 per cent, which occur in the Rocky Mountains, with curves up to 16 deg. The average train consists of 12 cars, although in the summer season the number occasionally reaches as high as 17. The majority of these locomotives operate over two divisions or sub-divisions of about 110 miles each, crews being changed at the end of each sub-division. In other cases the locomotives are assigned to the heaviest runs in such a way that they double the sub-division each day, there being in such cases either two crews assigned to each engine or three crews to two engines.

These Pacific type locomotives have a rated tractive effort of 41,900 lb. with 26 in. by 28 in. cylinders, and 73 in. driving wheels and weigh 314,000 lb., of which 181,000 lb. is on the drivers. They have boilers of the conical connection type with wide firebox, combustion chamber 39 in. long, tubes 18 ft. long, brick arch and superheater. The tenders are equipped with coal pushers.

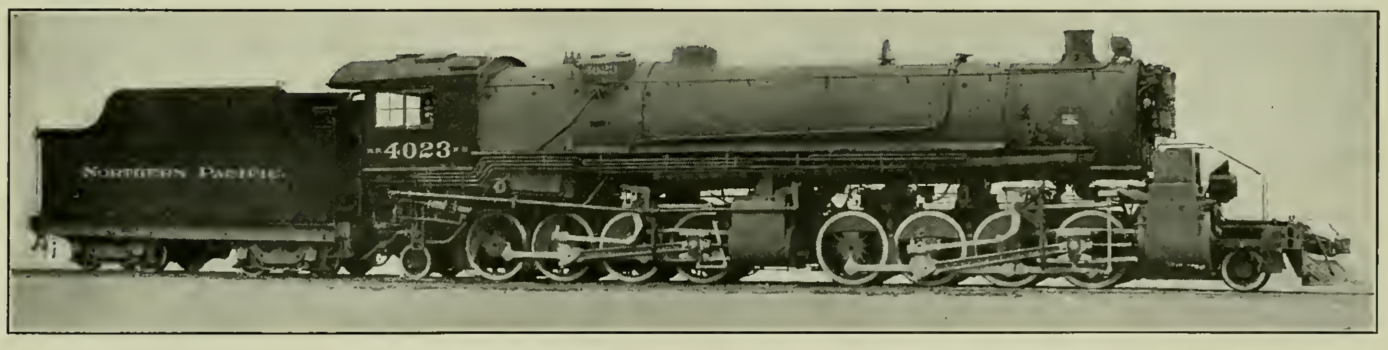
Mikado Type

The Mikado type locomotives, railroad Class W-3, are similar in design to previous locomotives which have been found to be well suited to general traffic conditions on the Northern Pacific. They are used in main line freight service on several divisions having profiles of different characteristics. On the Pasco division they run 153 miles, 90 miles of which is a 0.4 per cent continuous grade, and handle trains of 3,200 tons. The Yellowstone division profile between Mandan, N. D., and Glendive, Mont., is a series of ascending and descending grades, with ruling grades of 1.2 per cent both eastward and westward. The rating on this division is 1,775 tons in both directions. On the Seattle division between Auburn and Lester, Wash., a fairly uniform 1.0 per cent grade occurs, and the tonnage rating for this portion of the division is 1,600 tons. From Lester to the summit helpers are used and they are also employed on several other divisions in the mountainous sections.

These Mikado type locomotives have a rated tractive effort of 57,100 lb.; 28 in. by 30 in. cylinders and 63 in. driving wheels, and weigh 337,000 lb., of which 247,000 lb. is on the drivers. The boilers are of the conical connection type, provided with brick arches, combustion chambers 36 in. long, tubes 18 ft. long and superheaters.

Mallet Type

The Mallet type locomotives, railroad Class Z-3, are similar to previous 2-8-8-2 locomotives used on the Northern Pacific. They are employed as helpers in freight service on the Rocky Mountain and Montana divisions where grades are

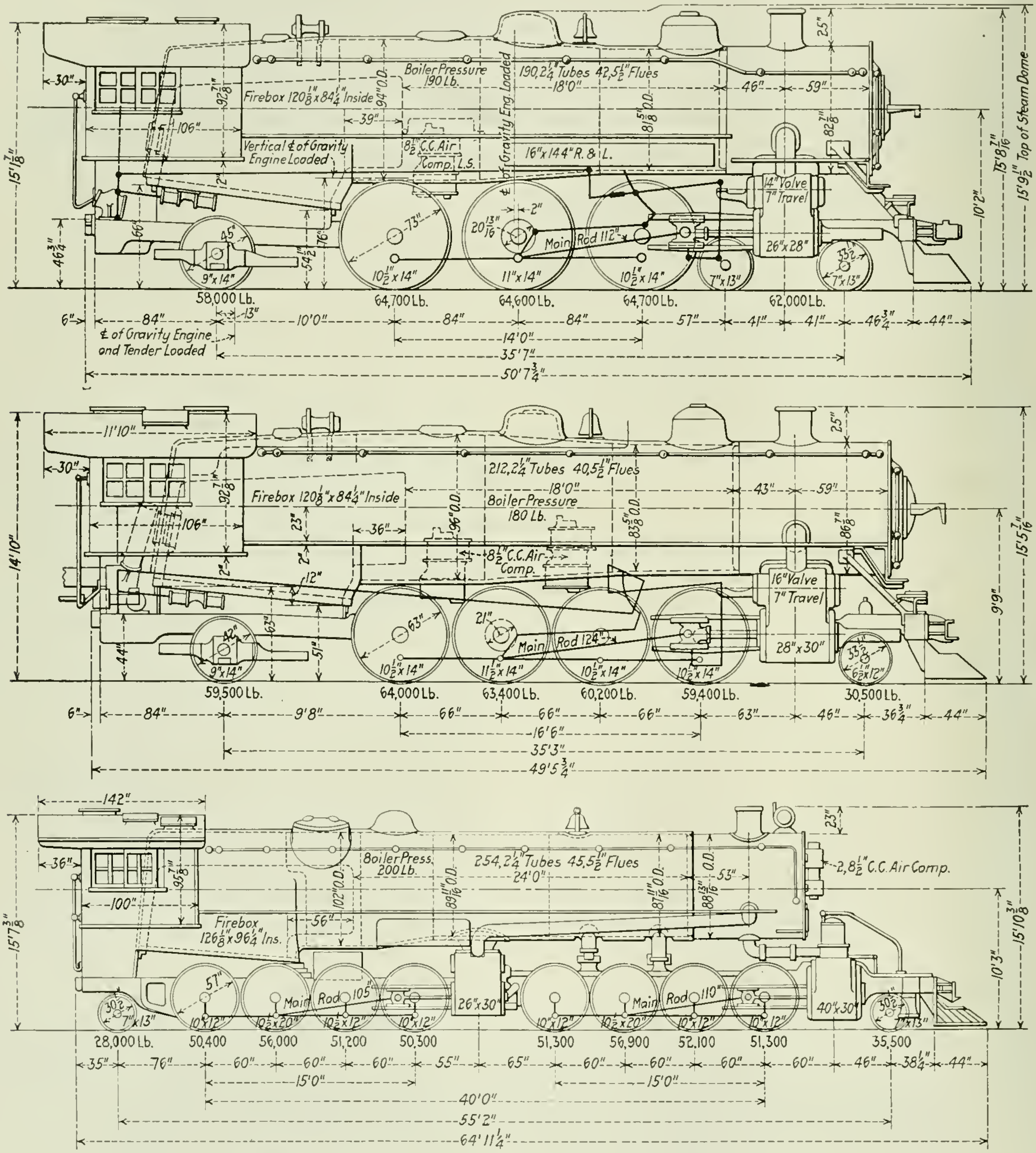


Mallet Type Locomotives Used Either as Road Engine or Helper heavy. On the Seattle division they are used as road engines, handling 2,400 tons between Auburn and Lester, the grade being uniformly 1.0 per cent. Helpers are used from Lester to the summit of the Cascade Mountains.

These locomotives have a rated tractive effort of 105,100 lb. operated simple and 87,600 lb. operated compound. They have a total weight of 483,000 lb. exclusive of the tender, of which 419,500 lb. is on the drivers. The high pressure cylinders are 26 in. by 30 in., the low pressure cylinders 40 in. by 30 in., and the driving wheels are 57 in. in diameter. The boilers are of the conical connection type, firebox 126⅛ in. by 96¼ in., with combustion chamber 56 in. long, tubes 24 ft. long, brick arches and superheaters.

Eight-Wheel Switchers

These locomotives are of a new design and resemble closely those ordered by the U. S. R. A. Both designs are of the same rated tractive effort, have the same size cylinders, driving wheels and wheel base and the boilers are similar. They have 25 in. by 28 in. cylinders, 51 in. wheels, weigh 217,000 lb., a wheel base of 15 ft. and are designed to operate on 19 deg. curves.



Side Elevations of Pacific, Mikado and Mallet Types for the Northern Pacific

Details and Specialties

Longitudinal boiler seams are welded for a length of 18 in. at front and back except the seams over the combustion chamber which are welded at the front end only on the Pacific and Mikado locomotives and are not welded on the Mallets. The top seam in the smoke box is also welded. The fireboxes of all types have the crown and side sheets made of a single piece. The combustion chamber is also made in one piece, butt welded on the bottom center line and butt welded to the firebox crown. Two 2 in. combustion tubes are used in each side of all fireboxes. Injectors are of the Hancock non-lifting type and feed water enters the boiler through vertical check valves. All boilers are equipped with Butterfly firedoors and brick arches. Duplex type D stokers are used on the Mikado and Mallet locomotives, and coal pushers on the tenders of the switcher and Pacific locomotives.

Driving axles are of hammered open-hearth steel, oil heat treated. Front truck, trailing truck and tender axles are of open-hearth carbon steel, oil heat treated, as are also the crank pins. On the Mallet engines the main crank pins are hollow bored. Bushings in cylinders and steam chests and also packing rings for main and valve pistons are of Hunt-Spiller iron. Extended piston rods are used on the Mikado locomotives and on the low pressure cylinders of the Mallets. Walschaert valve gear is used on all types. Ragonnet power reverse gear is applied to the switch engines, while the locomotives of the other types have Mellin reverse gears with oil pistons. Other specialties used are Pyle National electric head and back-up lights, Franklin grate shakers, pneumatic cylinder cocks and Chicago flange lubricators.

The important dimensions, weights and factors of the four types of locomotives are given in tabular form herewith.

Burning Coke Breeze with Bituminous Coal.—Tests were recently conducted by the Bureau of Mines, Department of the Interior, to determine the steaming value of coke breeze as a fuel when mixed with coal and fired by hand, and to see whether the mixture would give off an objectionable quantity of smoke.

The tests carried out showed that mixtures of the coarser coke breeze, which passed through a one-inch screen, with Pittsburgh coal gave less than one-half the smoke given out by Pittsburgh coal alone, about 20 per cent less steam, and required a stronger draft to burn them. The steaming value of the coarser coke breeze is about 70 per cent of that for the Pittsburgh run-of-mine coal, and to allow for the possible necessity of using steam jets to give the required draft, its price to compete with Pittsburgh coal for steam generation should be less than 70 per cent of the price for Pittsburgh coal.

The finer coke breeze, which passed through a one-half inch screen, was shown to give steam at nearly as high an efficiency and with practically the same draft as the coarser breeze at a low rate of steaming. But the draft required to burn it rose very rapidly and the thermal efficiency fell considerably at a somewhat higher rating, so that the finer coke breeze can be recommended only for use at low rates of combustion, and when used at this rating it emits more smoke than the coarser mixture emits.

Dimensions, Weights and Ratios of New Northern Pacific Locomotives

	Switch 0-8-0	Pacific 4-6-2	Mikado 2-8-2	Mallet 2-8-8-0
Tractive effort, 85 per cent, m. e. p.	51,000 lb.	41,900 lb.	57,100 lb.	105,100 simple 87,600 compound
Speed at estimated maximum horsepower	....	46.5 m. p. h.	11.8 m. p. h.	10.6 m. p. h.
Cylinders, diameter and stroke	25 in. by 28 in.	26 in. by 28 in.	28 in. by 30 in.	H.P., 26 in. by 30 in. L. P., 40 in. by 30 in.
Valves, kind and size	Piston, 14 in.	Piston, 14 in.	Piston, 16 in.	H. P., piston, 14 in. L. P. slide
Greatest travel	6½ in.	7 in.	7 in.	H. P., 6 in. L. P., 6 in.
Lap	1 1/16 in.	1¼ in.	1 3/16 in.	H. P., 15/16 in. L. P., 13/16 in.
Exhaust clearance	0	¼ in.	0	H. P., ¼ in. L. P., 7/16 in.
Lead in full gear	1/16 in	F, 1/16 in. B, 9/16 in.	⅛ in.	H. P., ¼ in. L. P., 3/16 in.
Weights in working order—				
On drivers	217,000 lb.	181,000 lb.	247,000 lb.	419,500 lb.
On front truck	....	69,000 lb.	30,500 lb.	35,500 lb.
On trailing truck	....	64,000 lb.	59,500 lb.	28,000 lb.
Total engine	217,000 lb.	314,000 lb.	337,000 lb.	483,000 lb.
Tender	163,000 lb.	198,600 lb.	214,000 lb.	213,000 lb.
Total engine and tender	380,000 lb.	512,600 lb.	551,000 lb.	696,000 lb.
Wheel base—				
Driving	15 ft. 0 in.	14 ft. 0 in.	16 ft. 6 in.	15 ft. 0 in., and 15 ft. 0 in.
Total engine	15 ft. 0 in.	35 ft. 7 in.	35 ft. 3 in.	55 ft. 2 in.
Total engine and tender	53 ft. ½ in.	71 ft. 3¼ in.	70 ft. 11¼ in.	83 ft. 6¼ in.
Wheels and journals—				
Driving wheels, diameter over tires	51 in.	73 in.	63 in.	57 in.
Driving journals, diameter and length—				
Main	10 in. by 12 in.	11 in. by 14 in.	11½ in. by 14 in.	10½ in. by 20 in.
Others	9 in. by 12 in	10½ in. by 14 in.	10½ in. by 14 in.	10 in. by 12 in.
Front, truck wheels	....	33½ in.	33½ in.	30½ in.
Trailing truck wheels	....	45 in.	42 in.	30½ in.
Tender wheels	33 in.	36 in.	36 in.	36 in.
Boiler, type	Straigth top	Conical Conn.	Conical Conn.	Conical Conn.
Steam pressure	175 lb.	190 lb.	180 lb.	200 lb.
Fuel	Bit. coal	Sub. Bit. Coal	Sub. Bit. Coal	Sub. Bit. Coal
Diameter, first ring, inside	78 5/16 in.	80 in.	82 in.	86 in.
Firebox, length and width	102 in. by 66¼ in.	120⅛ in. by 84¼ in.	120⅛ in. by 84¼ in.	126⅛ in. by 96¼ in.
Combustion chamber, length	....	39 in.	36 in.	56 in.
Arch tubes, number and diameter	3—3 in.	4—3½ in.	4—3½ in.	4—
Tubes, number and diameter	229—2 in.	190—2¼ in.	212—2¼ in.	254—2¼ in.
Flues, number and diameter	36—5½ in.	42—5½ in.	40—5½ in.	45—5½ in.
Tubes and flues, length	15 ft.	18 ft.	18 ft.	24 ft.
Heating surface, firebox	185 sq. ft.	300 sq. ft.	288 sq. ft.	332 sq. ft.
Heating surface, arch tubes	18 sq. ft.	35 sq. ft.	35 sq. ft.	41.6 sq. ft.
Heating surface, tubes	1,785 sq. ft.	2,002 sq. ft.	2,234 sq. ft.	3,575 sq. ft.
Heating surface, flues	772 sq. ft.	1,082 sq. ft.	1,030 sq. ft.	1,548 sq. ft.
Heating surface, total	2,760 sq. ft.	3,419 sq. ft.	3,587 sq. ft.	5,497 sq. ft.
Superheater surface	652 sq. ft.	928 sq. ft.	874 sq. ft.	1,305 sq. ft.
Equivalent heating surface	3,738 sq. ft.	4,811 sq. ft.	4,898 sq. ft.	7,454 sq. ft.
Grate area	47 sq. ft.	70.3 sq. ft.	70.3 sq. ft.	84.3 sq. ft.
Tender—				
Water capacity	8,000 gal.	10,000 gal.	10,000 gal	10,000 gal.
Fuel capacity	12 tons	14 tons	16 tons	16 tons
Ratios—				
Weight on drivers ÷ tractive effort	4.25	4.32	4.32	Simple 3.99 Compound 4.78
Tractive effort × diameter drivers ÷ equivalent heating surface	696	636	735	Simple 804 Compound 670
Equivalent heating surface ÷ grate area	79.5	68.4	69.7	88.4
Firebox heating surface ÷ equivalent heating surface, per cent	5.43	6.98	6.59	5.01
Total weight ÷ equivalent heating surface	58. 1	65.2	68.7	64 8

Preparation and Distribution of Fuel[*]

BY P. E. BAST

Fuel Engineer, Delaware & Hudson

THE railroads of this country use annually about 150,000,000 tons of coal. It was not at all improbable that five per cent more ash was included in railroad coal shipped during 1920 than in normal times. If this is true, 7,500,000 tons of additional ash was handled and hauled. But this tells only a part of the story. It has been authoritatively stated that there is a decrease of about 1½ per cent in efficiency for each additional one per cent ash content in the coal. The addition of the 5 per cent of ash means a reduction in efficiency of the good coal of about 7½ per cent, which together with the 5 per cent of ash makes a total reduction in efficiency 12½ per cent. Therefore, if five per cent more ash was included in the coal used by the railroads in 1920 than during normal times, it would be equivalent to 18,750,000 tons of coal with a money value of $75,000,000. Each one per cent reduction in extraneous ash would result in a saving of $15,000,000. To this must be added the waste in car mileage, the additional handling of ashes, delays to traffic, etc., the total of which is no inconsiderable amount. It would, therefore, appear that the preparation of railroad coal should command the careful attention of every railroad operating official.

It would seem reasonable that any railroad consuming an annual minimum of say 100,000 tons could well afford a mine inspection service, the expense of which would be negligible compared with the results possible to obtain.

Preparation of coal in the mine is the very foundation of fuel economy. The operator should feel his sense of responsibility in living up to the true intent of the railroad's contract or specifications, impressing upon his miners and other employees the necessity for clean coal, the railroads co-operating to the fullest extent through their mine inspectors.

The extraneous or free impurities in coal usually consist of slate, shale, mud seams, mother coal, sulphur balls or lenses, sand rock from the mine roof and clay from the mine floor. Sulphur, in the form of pyrites, shale, mother coal and thin slate partings are the most difficult to eliminate because they are more or less broken and intermingled with the coal when it is shot down, but with special care on the part of the miner during shooting and loading in the mine cars, these impurities can be thrown out and consigned to the dump pile. There should be no excuse for the loading of roof slate, sand rock, clay from the mine floor, thick slate bands, sulphur balls and lenses, inasmuch as any one of these last mentioned impurities can be detected in the mine and on railroad cars during loading.

Some coal seams have a distinct strata of bony coal. Precaution should be taken to eliminate this bony structure to a minimum. It could be used at mine power plants or disposed of locally.

Preparation of coal has so many varying angles that it would be difficult and unwise to set down any ironclad rules, yet it is believed that if the following few suggestions were carried out it would result in reducing the ash content of railroad fuel and would relieve the railroads of the burden and expense of transporting superfluous waste.

1. Periodical inspection of mine working places by proper mine authorities to see that coal is mined and prepared according to instructions.
2. Check system to determine the responsibility for loading dirty coal; discipline or docking, if law and agreements permit.
3. Shooting down coal so as to keep the percentage of slack down to a minimum.
4. Installation of picking tables where the nature of the coal requires extra precaution in preparation.
5. Proper and adequate drainage facilities.
6. Inspectors on railroad cars during loading to throw out removable impurities.

Consideration should be given co-operation of the railroad mine inspector and operator so that coals normally classified as undesirable can be made to meet the requirements of the railroads. This applies where coals least commercially salable are used by the coal bearing roads from a traffic development standpoint.

Expensive controversies and rejection of coal could be reduced to a minimum if the railroad would first obtain a complete inspection of the mines, showing all details of their methods of working, as well as of the coals offered before purchasing or making contracts.

Distribution

Distribution of coal is another important step in fuel economy. Like preparation, it is subject to many varying conditions such as irregularity of mine shipments, weather and traffic conditions, shortage of labor, power and car equipment, etc.

During the past three years distribution has been more or less demoralized due to motive power and car shortages, traffic congestion, labor disturbances, etc., and until these conditions have become stabilized for a comparatively reasonable period distribution will still continue to be subject to necessity.

It would be rather difficult to estimate or even approximate the annual loss to the railroads on account of poor distribution, such, for instance, as the placing of improper equipment under load at coaling platforms, stations, chutes and storage systems; overstocking, causing extra handling and per diem charges on foreign cars; the loss from a shortage of coal which necessitates holding back revenue tonnage in order to rush coal to some particular point, also in many cases, much to the displeasure of the shipper and inconvenience of the consumer, making it necessary for the railroad to confiscate commercial shipments in transit, which must be paid for at a relatively high price, and last but not least, cross-hauling.

There seems to be a difference of opinion among railway officers as to the department to handle the distribution. This is evident from a survey of thirty railroads covering practically every section of the country. The distribution by departments was as follows: transportation, 16; fuel, 9; mechanical, 2; purchasing, 2; by committees, composed of representatives of different departments, 1.

When we consider the variations in the different coals used by the railroads it can readily be seen how important it is that the coal distributor be familiar with the product that he is distributing. However, on many railroads this is not the case, and the lack of this knowledge has resulted in the slowing up of transportation by the distribution of coals to certain districts where the crews were not familiar with them or the power conditioned for their use.

Every railroad should have a distribution schedule based on the location of mines and characteristics of the coal so far as grade and quality are concerned. Since contract coal for any particular railroad using a large tonnage is bound to be of varying qualities, it would seem preferable to select the most desirable coal contracted for as a standard, the other coals then being compared and computed in terms of the standard. Distribution would then be simplified, so far as supplying to each district and class of service a uniform grade and quality of coal, which is a very important item from a standpoint of fuel conservation.

Distribution in a general sense is not a one department problem, it requires the closest co-operation of the several

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[*] Abstracted from a paper presented before the 1921 convention of the International Railway Fuel Association.

departments and with this in view the following suggestions are made regarding the distribution of supply coal:

1. A consumption schedule for all points, frequently revised and kept up to date to meet the demands of traffic, etc.
2. A distribution schedule showing coals contracted for, grading of coals to a fixed standard, showing grades and qualities most suitable for each district and class of service.
3. A schedule showing coal consigned from mines to be shipped preferably to point of consumption with a view of eliminating extra handling and cross-haulage.
4. Daily telegraphic report showing coal on hand under load at each coaling station.
5. Daily telegraphic report covering shipments of coal and receipts at junction points, in order to keep the loads up to a reasonable degree of safety and down to a minimum with reference to transportation needs.
6. Storage of coal during summer months, relieving the road from transporting company coal in the winter months during the season of peak load. This has special reference to railroads located beyond a reasonable distance from coal fields.
7. From a purchasing standpoint, the most economical grade and quality of coal for each district with consideration to price, freight rates, mine locations, etc.

Discussion

Most of the discussion dealt with the problem of preparation of coal at the mine, C. F. Richardson (West Kentucky Coal Company) frankly discussed the usual relations between the railroad and the mine and stated emphatically that in order to get clean coal the railroads must be ready to pay a price that will make it possible for the operator to pay the men required on the picking table. He suggested that the railroad purchasing agent might well pay a premium for 100 per cent coal, rather than to buy 70 per cent coal and 30 per cent rock, on a price basis only. He also stated that the demand for tonnage by the railroad is not an incentive for the operator to clean his coal properly, since thoroughly cleaned coal reduces the tonnage output of the mine.

Eugene McAuliffe pointed out that while the B.t.u. basis of purchasing coal is probably the best available, it is not an accurate standard, because variations in ash produce a disproportionate effect on the heating value of the coal beyond the direct effect on the B.t.u. content.

The importance of having a coal distributor was pointed out by W. L. Robinson (B. & O.), in order to avoid the necessity for confiscating commercial coal for railroad use to meet the immediate requirements of some stations. Such coal frequently costs as high as $16 a ton.

Important Factors in Design of Locomotive Boilers

Boilers Should Be Proportioned on Cylinder Horsepower and Air and Gas Areas Considered

BY J. T. ANTHONY
Vice-President, American Arch Company

This article is a continuation of the discussion in regard to the factors which should be considered in comparing the design of various locomotives. In this connection attention is called to an article in the Railway Mechanical Engineer of April, 1921, *page* 211, *by Lawford H. Fry, on the Comparison of Locomotive Dimensions and to articles by E. C. Poultney on the Dimensions and Proportions of British Locomotives in the Railway Mechanical Engineer for September and October,* 1921.—Editor.

In my opinion too much stress is laid on the mere subject of heating surface and too little attention is paid to the location and distribution of the heating surfaces. Some of the most important factors in design are the ratio of the tube length to the inside diameter; the ratio of the firebox heating surface to the total heating surface; the ratio of the superheating surface to the total heating surface; and particularly the relation between the net gas area through the tubes and the power to be developed.

In Table I are shown some of the most important data on four designs of Mikado (2-8-2 type) locomotives, together with the ratios, which, to my mind, are important. The last two—the ratio of the air inlet through the ash pan and through the grates to the grate area—are never shown and are probably considered a matter of no importance; but I am satisfied that the lack of attention paid to these ratios is costing our railroads a lot of money.

In designing the locomotive boiler the method usually followed is to determine the cylinder horsepower output at a piston speed of 1,000 ft. per min. for superheated locomo-

TABLE 1

Dimensions and Factors of Typical Mikado Locomotives

Road	G. T.	I. C.	S. A. L.	Penn.
Tractive effort	51,600 lb.	51,700 lb.	50,200 lb.	57,850 lb.
Cylinders, diameter and stroke	27 in. by 30 in.	27 in. by 30 in.	27 in. by 30 in.	27 in. by 30 in.
Weight on drivers	204,700 lb.	218,300 lb.	208,000 lb.	235,800 lb.
Total weight of engine	272,100 lb.	282,700 lb.	282,000 lb.	315,000 lb.
Cylinder horsepower	2,296	2,296	2,230	2,690
Boiler pressure	175 lb.	175 lb.	170 lb.	205 lb.
Boiler type	W. T.	Straight	Ext. W. T.	Belpaire
Boiler, outside diameter, front end	74 in.	82 in.	74 in.	80½ in.
Tubes, number and diameter	240–2-in.	262–2 in.	230–2 in.	237–2¼ in.
Flues, number and diameter	32–5⅜ in.	36–5⅜ in.	32–5⅜ in.	40–5½ in.
Tubes and flues, length	20 ft. 0 in.	20 ft. 6 in.	20 ft. 0 in.	19 ft. 0 in.
Heating surface, firebox	249.8 sq ft.	272.2 sq. ft.	247 sq. ft.	302 sq. ft.
Heating surface, tubes and flues	3,400 sq. ft.	3,834 sq. ft.	3,295 sq. ft.	3,716 sq. ft.
Heating surface, superheater	769 sq. ft.	887 sq. ft.	760 sq. ft.	1,172 sq. ft.
Heating surface, total (including superheater)	4,418.8 sq. ft.	4,993.2 sq. ft.	4,302 sq. ft.	5,190 sq. ft.
Net gas area through tubes and flues	6.39 sq. ft.	7.06 sq. ft.	6.23 sq. ft.	8.44 sq. ft.
Grate area	56.5 sq. ft.	70.4 sq. ft.	63.2 sq. ft.	70.0 sq. ft.
Firebox volume	....	....	....	427 cu. ft.
Air inlets through ashpan	....	....	....	8.44 sq. ft.
Air inlets through grates	....	....	....	19.43 sq. ft.
Weight on drivers ÷ total weight	0.752	0.772	0.737	0.749
Weight on drivers ÷ tractive effort	3.97	4.22	4.14	4.11
Total weight ÷ tractive effort	5.27	5.47	5.62	5.45
Total weight ÷ cylinder horsepower	119	123	127	117
Cylinder horsepower ÷ grate area	40.6	32.6	35.3	38.4
Cylinder horsepower ÷ gas area	359	325	358	319
Tube length ÷ inside diameter of tube	137	140	137	114
Total heating surface ÷ cylinder horsepower	1.92	2.17	1.93	1.93
Superheater surface ÷ total heating surface	17.4	17.7	17.6	22.58
Firebox heating surface ÷ total heating surface	5.65	5.45	5.74	5.81
Firebox volume ÷ grate area	....	....	....	6.10
Air inlet through grate ÷ grate area	....	....	....	28.8
Air inlet through ash pan ÷ grate area	....	....	....	11.1

tives, and from this figure determine the grate area on the supposition that one horsepower hour requires 3¼ lb. of coal, the maximum allowable rate of combustion being 120 lb. of coal per square foot of grate per hour. The total steam required per hour is obtained by multiplying the cylinder horsepower by 20.8 for superheated locomotives, and the amount of heating surface required to give this evaporation is based on the Coatesville test which showed 55 lb. evaporation per square foot of firebox heating surface, and about 10 lb. for tube heating surface.

I am satisfied that these evaporation figures can be, and often are, greatly exceeded in locomotive practice, and that the main problem is to design a firebox that will liberate the heat; then provide sufficient gas area to enable the firebox to free itself of the gases of combustion, without unduly high drafts: and last, to determine the correct proportion between the diameter and length of the tubes. A logical method for the design of locomotive boiler would be about as follows:

Cylinder horsepower, according to the American Locomotive Company method = .0229 x P x A where

P is equal to boiler pressure and

A is equal to the area of one cylinder in square inches.

$$\text{Grate Area} = \frac{\text{Cyl. h.p. x 3.2}}{120} \text{ for Coal of 14,000 B.t.u.}$$

If coal of inferior quality is to be burned it is necessary to burn more of it in order to get the same heat output, and if the poorer coal is to be burned with the same degree of efficiency it is necessary to keep the rate of combustion down to 120 lb., which requires a larger grate. Therefore the grate area should be equal to

$$\frac{\text{Cyl. h.p. x .37}}{\text{1000 B.t.u. in coal}}$$

With poor Western coal running 11,000 B.t.u., this gives a rather large grate area, but as most heavy engines are now being stoker-fired there is no logical reason why the larger grates should not be used. Of course, the argument against the larger grate is that it increases the standby losses. If a locomotive is designed to adorn the terminal tracks and sidings the argument is effective; but if it is designed to haul heavy trains at fair speeds and at the same time to burn a poor quality of coal efficiently, the larger grate will prove more economical than the smaller one, regardless of the standby losses.

TABLE 2

Locomotives as Redesigned by Suggested Ratios

Road	G. T.	I. C.	S. A. L.	Penn.
Tractive effort	51,600 lb.	51,700 lb.	50,200 lb.	57,850 lb.
Cylinders, diameter and stroke	27 in. by 30 in.	27 in. by 30 in.	27 in. by 30 in.	27 in. by 30 in.
Boiler pressure	175 lb.	175 lb.	170 lb.	205 lb.
Cylinder horsepower	2,296	2,296	2,230	2,690
B. t. u. per lb. of fuel used	12,500	12,000	13,500	14,250
Grate area	68 sq. ft.	70.8 sq. ft.	61.1 sq. ft.	70 sq. ft.
Net gas area, sq. ft. = cylinder horsepower ÷ 330	6.96	6.96	6.76	8.15
Tubes, number and diameter	256–2 in.	256–2 in.	246–2 in.	290–2-in.
Flues, number and diameter	36–5⅜ in.	36–5⅜ in.	36–5⅜ in.	44–5⅜ in.
Tubes and flues, length	17 ft. 6 in.	17 ft. 6 in.	17 ft. 6 in.	17 ft. 6 in.
Firebox heating surface, approx	290 sq. ft.	320 sq. ft.	287 sq. ft	330 sq. ft.
Tube and flue heating surface, approx	3,230 sq. ft.	3,230 sq. ft.	3,140 sq. ft.	3,740 sq. ft.
Superheating surface, approx	720 sq. ft.	720 sq. ft.	720 sq. ft.	1,188 sq. ft.
Heating surface, total (including superheater)	4,240 sq. ft.	4,270 sq. ft.	4,147 sq. ft.	5,258 sq. ft.
Firebox volume	*50 cu. ft.	*60 cu. ft.	*50 cu. ft.	457 cu. ft.
Total heating surface ÷ cylinder horsepower	1.85	1.86	1.86	1.95
Superheater surface ÷ total heating surface	17.00	17.00	17.3	22.6
Firebox heating surface ÷ total heating surface	6.84	7.49	6.92	6.27

*The firebox volumes under the first three locomotives could not be shown, due to lack of data; but shortening the tubes to 17 ft. 6 in. length increases the present firebox volume by the amount shown.

Having determined the grate area the question of net gas area through the flues should next be considered.

According to the best information available when firing a high grade Pennsylvania coal at the rate of combustion of 120 lb. of coal, there is formed about 10.35 lb. of gas for each pound of coal fired, which equalled, in the particular locomotive, 9,660 lb. of gas per hour per square foot of flue opening. At higher rates of combustion there is a decrease in weight of gas per pound of coal, and but a slight increase in the total weight of gas formed. Thus at the rate of 170 lb. of coal per square foot of grate per hour only 10,800 lb. of gas pass through each square foot of tube and flue opening. It is possible that even a greater weight of gas could be put through each square foot of opening without unduly increasing the draft; but I have no accurate data as to this. Using 10,800 lb. as a base figure, however, the net gas area required is

$$\frac{\text{Cyl. hp. x 3.2 x 10.35}}{10{,}800} = \frac{\text{Cyl. hp.}}{330}$$

Having determined the gas area required this would be apportioned between the superheater and the smaller tubes as follows, using 40 per cent of the area for superheater flues:

$$\text{No. Units } 5\tfrac{1}{2} \text{ in. Flues} = \frac{\text{Gas area in sq. in. x 0.4}}{11.78}$$

$$\text{No. Units } 5\tfrac{3}{8} \text{ in. Flues} = \frac{\text{Gas area in sq. in. x 0.4}}{10.78}$$

The remaining 60 per cent of gas area goes to be used for the 2 in. or 2¼ in. tubes.

$$\text{No. Tubes} = \frac{\text{Remaining gas area in sq. in.}}{\text{Area of one 2 in. or } 2\tfrac{1}{4} \text{ in. tube}}$$

The length of the tubes should not be in excess of 120 times the inside diameter. While, personally, I think that 110 is a better ratio, I have used the larger figure to be conservative. A 2-in. tube with 1¾ in. inside diameter would, therefore, be 17 ft. 6 in. long, and a 2¼ in. tube with 2 in. inside diameter would be 20 ft. long. The use of the shorter tubes in long wheel base engines of the Mikado, Pacific and Santa Fe types would, of course, necessitate longer combustion chambers, and this, to my mind, is an advantage. I would make the combustion chamber as long as necessary to connect the tubes with the firebox.

In Table 2 are shown the same locomotives as in Table 1, with the boilers figured according to the method above outlined and some of the resulting ratios. Different grades of fuel have been used for the four roads in order to illustrate their effect on the grate area. The ratios between the grate area and heating surface have not been shown, as with the above method of boiler design differences in such ratios would only indicate a difference in the B.t.u. content of the fuel.

It will be noted that no mention has been made of cylinder volume, nor have any ratios been shown containing this item, as it is of no importance and should be replaced by the cylinder horsepower.

The ratio of firebox volume to grate area should be at least six and as much greater as is possible to obtain.

I have not made any calculations as to the increase or decrease in weight of boilers which would be brought about by the suggested methods of designing, but this should differ but little from the results when following present practice.

European View of Steel vs. Copper Fire-Boxes*

Extensive Tests on the Orleans Railroad Demonstrate Superiority of Steel Fireboxes

BY PAUL CONTÉ

It can be said, in a general way, that the fire-boxes of the boilers of locomotives are made of steel in the United States, whereas almost everywhere else they are made of copper, particularly in Europe. It cannot be given as a reason for the greater use of copper that this metal is a better conductor of heat. The trials made by the Pennsylvania Railroad, at Altoona, with locomotives equipped with steel fire-boxes showed that the heating surface gave forth as much heat in the case of these fire-boxes as with the fire-boxes of the boilers made of copper, and it is, moreover, a well known fact that the power of the boilers was not diminished when copper tubes were replaced by steel. As far as the ease of making repairs is concerned, this is about the same with the steel as with the copper fire-boxes, and it can even be said that, since the practical use of autogenous welding, repairing is easier with the steel than with the copper fire-boxes.

In Europe extensive trials at replacing copper fire-boxes with steel have failed because the steel fire-boxes suddenly cracked either in the middle of the plates or else fissures appeared radiating from the rivet holes, and these accidents appeared to be the result of the rapid cooling of the plates. We were, therefore, led to conclude that, in order to maintain the steel fire-boxes in good condition, it was necessary to avoid submitting them to any rapid change in temperatures, and the reason the Americans were able to continue to use steel fire-boxes was because of the special precautions which they must have taken to avoid these rapid changes and which we in Europe knew nothing about. During a trip for study to the United States, we were able to examine these precautions closely, and we found that they could be summed up in two definite rules:

1. The boiler should never be washed except with hot water and it should also never be filled except with hot water.
2. The formation of scale on the lining of the fire-box should be avoided as much as possible.

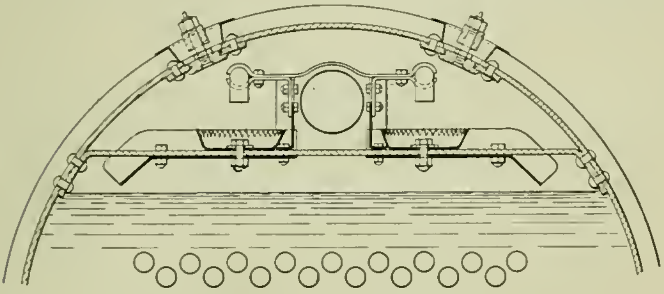

Fig. 1—"Trick Feeds" Used on Locomotives of the Paris-Orleans

The washing and the filling with hot water is now performed in the large American terminals by using fixed pipes fed by special boilers. In terminals of lesser importance, the injector of an engine under steam is used. It was therefore necessary before renewing the trials of the steel fire-box on the Orleans railroad, to begin by spreading the practice of washing and filling the boilers with hot water, either by employing the injector of a locomotive under steam, or by some other means. It was only when this custom had been generally adopted on the railroad that we were able to again take up the trials of the steel fire-boxes.

These trials began in 1907. In order to carry them out under the best conditions, the 12 fire-boxes put into service from 1907 to 1908 were ordered in the United States and delivered completely erected. The staybolts were also made from charcoal iron bars from the United States. Furthermore, in order to avoid as far as possible the formation of scale on the lining of the fire-box, it was decided to use in connection with the trial boilers a special system of steam feeding which allows the water employed for filling to be heated by the steam of the boiler to a temperature near that of the saturated steam.

"Trick Feeds" on the Orleans Railroad

This very simple system, called on the Orleans railroad "Trick Feeds," is composed merely of a tray placed inside the body of the boiler shell above the normal level of the water, and on which the water for filling the boiler falls. (See Fig. 1.) The water spreads out in a thin layer on the tray before running into the boiler, is heated by the contact with the steam and the scale falls off in small particles which drop on the tray or run along the walls of the barrel to its bottom. The crystallizing of the scale on the walls of the boiler and particularly on those of the fire-box is thus avoided. It is naturally necessary to place a handhole outside the cylinder and above the tray in order to allow the complete cleaning of the tray.

These "Trick Feeds" have been placed on all the locomotives of the Orleans railroad constructed since 1906 with copper or steel fire-boxes and have never been the cause of any trouble. The boilers show a minimum amount of scale. Furthermore, by heating the supply water to the temperature of the water of the boiler, an equal temperature is obtained at all points of the boiler and in this way the formation of colder zones is avoided in the bottom of the barrel and in the water legs. We also noticed that with the engines equipped with "Trick Feeds" the lapse of time between heavy boiler repairs, such as the replacing of the tube sheet or the fire-box, was noticeably longer than with the locomotives of the series constructed before that time and which were not so equipped; but as different types of locomotives were concerned we were unable to draw definite conclusions.

Story of the Tests

The first use of steel fire-boxes was made in 1907 and 1908 on 12 locomotives, six of which were of the 2-4-6 type with a grate surface of 18.4 sq. ft. and six of the 0-8-0 type with a grate surface of 18 sq. ft. As this trial gave good results, it was continued and in 1909 and 1910 steel fire-boxes were placed on 27 boilers, 16 on 2-4-2 type locomotives and 11 on 0-8-0 type locomotives of the same sort as previously. In 1914, 40 more were added. In 1915, it was decided to replace with composite fire-boxes (rear plate only of copper) the copper fire-boxes of the old locomotives which had reached the limit of their service. Finally in 1918 and 1919 the Orleans railroad put into service 150 Mikado locomotives constructed in the United States with fire-boxes entirely of steel. At the end of 1917 the Orleans railroad had in service nine tube plates or composite fire-boxes on the

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*Abstract of an article appearing in the Revue Generale des Chemins de Fer. Mr. Conté is a naval constructing engineer and also assistant chief engineer of the Central Office for the Study of French Railway Equipment.

four-cylinder compound engines and 160 fire-boxes of steel or composite on the old locomotives.

Results of the Trials

As regards heat transmission it was found that there was no difference between similar locomotives, whether the fire-boxes were of steel or of copper. From the point of view of upkeep, the trials showed a noticeable advantage in favor of the steel fire-boxes. In general the steel fire-boxes gave very good results. The locomotives of the 2-4-2 and 0-8-0 types had the door frames and the frames of the openings of solid forged iron which were retained. The result of this was that the part of the rear plate in contact with the frames was not heated by the water of the boiler. With the copper plate this arrangement does not give much trouble. The edge of the plate burns gradually, but only cracks after a long while, and a piece can be added to the rear plate around the frames of the door after a certain number of years. It is not the same when the rear plate is made of steel. At the end of a few years we noticed, as in the case of the Paris, Lyons, Mediterranean trials in 1893, that cracks showed themselves in the part of the plate in contact with the frame. These tests extending over a period of 11 years showed that in cases where solid frames were used for the door openings, it was preferable to make the rear plate of copper, and since 1914 all the steel fire-boxes installed in our locomotives under these conditions were composite fire-boxes. We have not, however, abandoned the idea of constructing complete fire-boxes of steel, and in the new spare boilers for locomotives of the 0-6-0 type put into service in 1918, as well as in the 150 Mikado engines in 1917, we constructed the fire-box entirely of steel, taking the precaution, however, to protect the part of the plate in contact with the door by a flame-shield and abolishing the small openings of this door. As the boilers were new, we took advantage of this fact to adopt a type of door opening in towards the fire-box which made it easier to install a proper flame-shield as mentioned above.

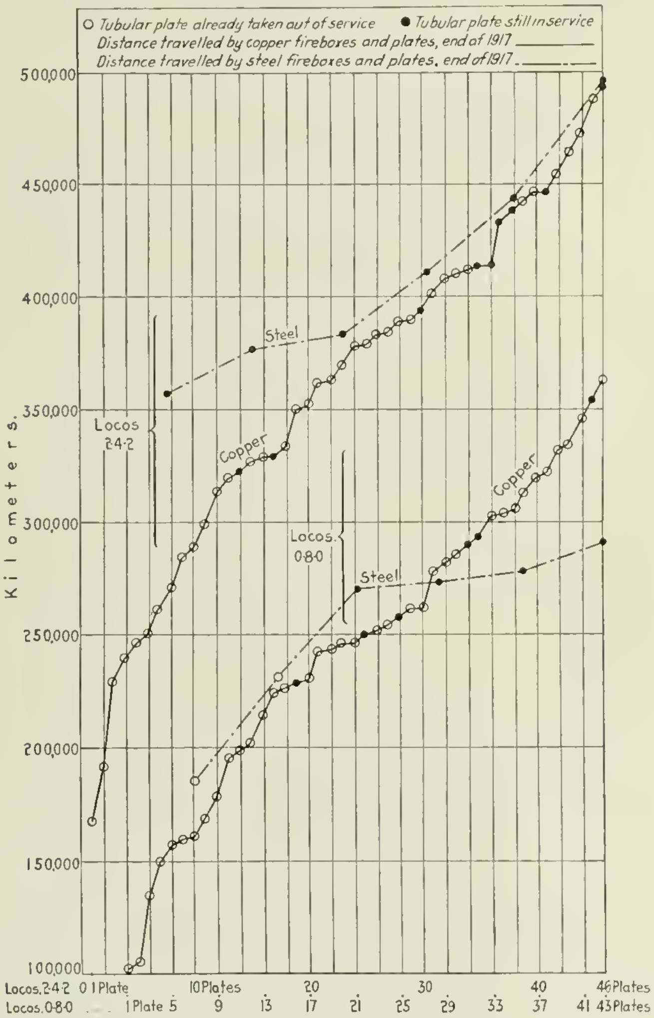


Fig. 2—Results of Tests of 1907-1908

As regards the 40 composite fire-boxes installed in 1914, at the end of 1918, we found trouble only in the case of three fire-boxes of locomotives of the 0-8-0 type resulting from circumstances which are worth while relating in order to show the ease with which steel fire-boxes are affected by cold. In these three locomotives from the Tessonnieres Terminal, with composite fire-boxes, cracks were found at the same time in 1916, in their sides, and in one of them in the tube plate, opposite the handholes for the washing of the outside envelope. An examination was made and it was found that, in order to easily do the washing, it was necessary to move the engines out of the terminal, and that the prevailing wind, which is very strong in that region, came from such a direction when the locomotive was at the wash-stand that it blew directly through the holes for washing and struck the plate opposite as soon as the cover was detached. As these cracks only occurred on one side of the engine, and always the same, it was proved that it was certainly the action of the wind which caused the cracks.

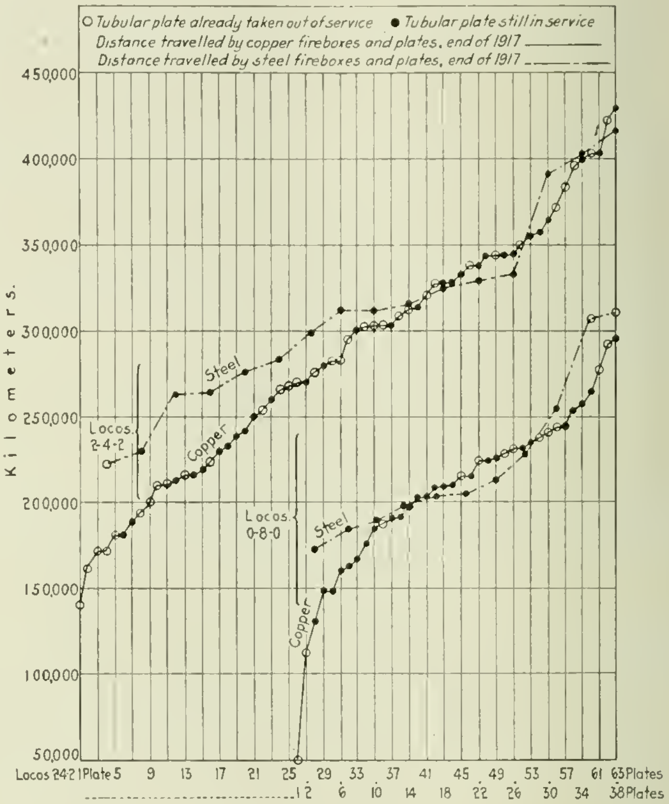


Fig. 3—Results of Tests of 1909-1910

Lasting Qualities of Steel and Copper Fire-Boxes

The criterion for judging the wearing qualities of a fire-box is the distance traveled by the locomotive between the time the fire-box is installed and when it is replaced. As this distance is very great, both for the copper and for the steel fire-boxes, we have had to limit ourselves to comparing the distance traveled between the time of putting into service and the replacing of the tube plate, this plate being usually the first part which has to be replaced in a fire-box.

Six steel fire-boxes were installed in 1907 and 1908 on passenger engines of the 2-4-2 type. Up to the present time no tube plate has been replaced. The average distance traveled by the six engines was 257,375 miles at the end of 1917. During the same period, 1907 and 1908, 46 copper fire-boxes or tubular plates were installed on the other locomotives of the same series. Out of the 46 plates, 38 had been replaced and the average distance traveled by these 46 engines, at the end of 1917, with the fire-boxes or tube plates installed in 1907 and 1908, was 225,000 miles. Out of the six steel fire-boxes placed on the locomotives of the 0-8-0 type, two tube plates were replaced after traveling an average distance of 130,000 miles. The average distance traveled by the six fire-boxes was 159,375 miles at the end of 1917. During the same period, 1907 and 1908, 43 copper fire-boxes or tube plates had been installed on locomotives of the same series. Thirty-seven have been replaced at the present time and the average distance traveled by these 43 fire-boxes or plates was 153,750 miles at the end of 1917.

The curves (Fig. 2), which show the distance traveled at the end of 1917 by all the plates, furnish an idea of the service given by the copper and by the steel plates.

Sixteen steel fire-boxes were installed in 1909 and 1910 on engines of the 2-4-2 type. Up to the present time only one tube plate had been replaced after traveling 138,750 miles. The average distance for these 16 fire-boxes was 194,375 miles at the end of 1917. During this same period —1909 and 1910—63 copper plates or fire-boxes had been placed on locomotives of the same series. At the present time 34 plates have been replaced and the average distance travelled at the end of 1917, by the 63 plates or fire-boxes was 179,375 miles.

Eleven steel fire-boxes were replaced during the same period on locomotives of the 0-8-0 type. Two fire-boxes were replaced after making an average of 194,375 miles. The average mileage made by the 11 fire-boxes was 136,250 miles at the end of 1917. During this same period, 1909 to 1910, 38 copper plates or fire-boxes were installed on engines of the same series. Fourteen tube plates have already been replaced and the average distance of the 38 tube plates or fire-boxes at the end of 1917 was 129,375 miles.

The curves in Fig. 3 show the comparative mileage made by the copper and the steel plates.

Effect of Scale on Steel and Copper Fire-Boxes

Contrary to what might have been expected at first thought, we noticed no particular effect on the steel fire-boxes caused by the nature of the water. We found no corrosion in the case of the fire-boxes filled with water of a nature likely to corrode the tubes. Furthermore, in the case of the steel or composite fire-boxes in service in the terminals of the railroad, particularly at Etampes and Capdenac where the water is very calcareous and contains a large percentage of calcareous salts, we noticed no formation of scale and no difficulty arose while in service, whereas the copper fire-boxes, fed with the same water, showed abnormal wear and cracks between the holes of the tubular plates. We must add that, during the war, a certain number of engines of the 0-8-0 type were used in the field service, particularly on the Nord railroad where the water is very calcareous. In spite of the special conditions under which these locomotives were used, no trouble with the fire-boxes has been brought to our attention.

It should be stated in connection with these tests that the steel fire-boxes were installed under the same conditions as the copper ones, without taking any special precautions. The rods were rivetted at the two ends and given a head slightly reduced in size, without receiving the usual finish of the copper rods. The assembling of the tubes in the tube plates was done by the American method: that is to say, by inserting a thin plate of copper between the tube and the plate and then expanding the tubes driving them into the plate and turning down the edges.

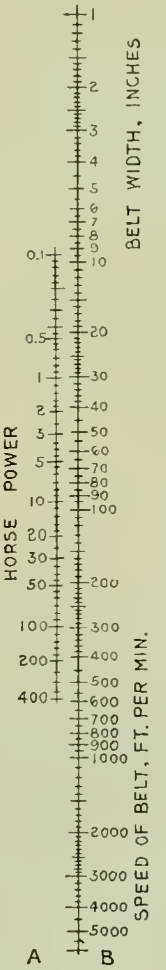
This method gave the best of results, and when the work is well done it is unnecessary to touch it again.

Conclusions

As a result of the very thorough trials which we have just described, we are convinced that by using the special precautions, which we have mentioned in this article, steel or composite fire-boxes can be substituted for copper ones. It would even seem that the length of service of steel fire-boxes were greater than that of the copper ones. Moreover, as the steel fire-boxes are much lighter and cheaper than those of copper, this conclusion is of the greatest importance. We draw attention again, however, to the absolute necessity, before making a trial or installing a large number of steel or composite fire-boxes on a railroad, of beginning by making it a general custom to do the washing and the filling of the boilers with hot water, in order that this may be the general practice, before putting the steel fire-boxes into service. A locomotive, as a matter of fact, has to go to several terminals of the railroad. The washing and filling with hot water should therefore be a general custom at all points. Otherwise one would run the risk of putting the fire-box out of service by one single washing with cold water done under bad conditions.

Chart Gives Power of Belts

BY W. F. SCHAPHORST



The accompanying chart will be found handy by belt men, or purchasers of belts, for figuring the belt width necessary to transmit any given power knowing the horsepower that is to be transmitted and knowing the speed of the belt. Likewise if the belt width and speed are known the horsepower can be determined, or if the belt width and horsepower are known, the speed at which the belt should be run is easily found.

For example, it is desired to transmit 10 hp. through a single leather belt, the belt speed to be 3,000 ft. per min. With a sheet of paper find the distance from the 10 in column *A* of the chart illustrated to the 3,000 in column *B*. Then step off the same distance upward from the 10 in column *A* to a point in column *B* and find the answer—3 in. wide.

Again if we have a belt 4 in. wide and wish to transmit 20 hp. with it, what must be the speed of the belt? With the same sheet of paper measure the distance from the 4, column *B*, to the 20, column *A*. Then from the 20, column *A*, measure downward the same distance to a point in column *B* and there is the answer—4,000 ft. per min.

Suppose that a 9-in. single belt is running at 2,000 ft. per min. What horsepower will it transmit? Find the mid-point between the 9, column *B*, and the 2,000, column *B*. Directly opposite the mid-point in column *A* is the answer—22.5 hp. An easy way in which to find the exact mid-point is to lay a sheet of paper along column *B*, the upper corner being exactly opposite the 9-in. column *B*. Make a mark on the sheet of paper opposite the 2,000, column *B*. Then fold the paper bringing the upper edge down to the mark and make a crease in the paper at the mid-point.

Turntable Indicating Device

BY M. A. BOUYSOV

Considerable time is often lost at terminals in shifting a locomotive back and forth on a turntable until the table is in balance and can be readily revolved without unnecessary waste of power. Moreover, it is usually necessary to have a second man on the ground to signal the hostler when the locomotive has been placed correctly. To obviate these difficulties the turntable indicating signal, illustrated in Fig. 1, was applied in April, 1921, having been in service up to date with good results. The device was installed after an accident due to failure of the electric generator when it was necessary to operate this table with laborers. During this time it was noticed that with the table properly balanced it could be handled by two men and when not perfectly balanced it required from six to eight men to move it.

Fig. 1—View Showing Indicator Applied at Each End of the Turntable

With the indicator illustrated, it is now possible to tell when the table is balanced without the common practice of having an additional man at the end of the table to signal the hostler. Referring to Fig. 1 it will be evident that one signal is placed at either end of the turntable so as to be visible to the hostler no matter which way the locomotive is turned. The signal itself is a three-position signal, with bull's eye and semaphore blade. With the table balanced, both blades will stand in a horizontal position and when the table is unbalanced the flag at the high end will be tipped up, that at the other end being tipped down. The construction and operation of the turntable indicator will be evident from a close inspection of Fig. 2. The signal is operated by means of a vertical rod connected at its lower end to a hinged arm with a wheel traveling on the track. When a locomotive comes on one end of the turntable, that end goes down, but the wheel remaining at the same elevation on the track forms a fulcrum by which the vertical arm is pushed up, causing the blade to take a position below the horizontal. The relative proportions of wheel diameter and arm length are such as to bring the semaphore blade horizontal when the turntable is in a balanced position. With the construction described above it is evident that the indicator shows accurately whether the turntable is balanced or not, and if unbalanced, which way the locomotive will have to be moved to correct this condition and facilitate turning the table.

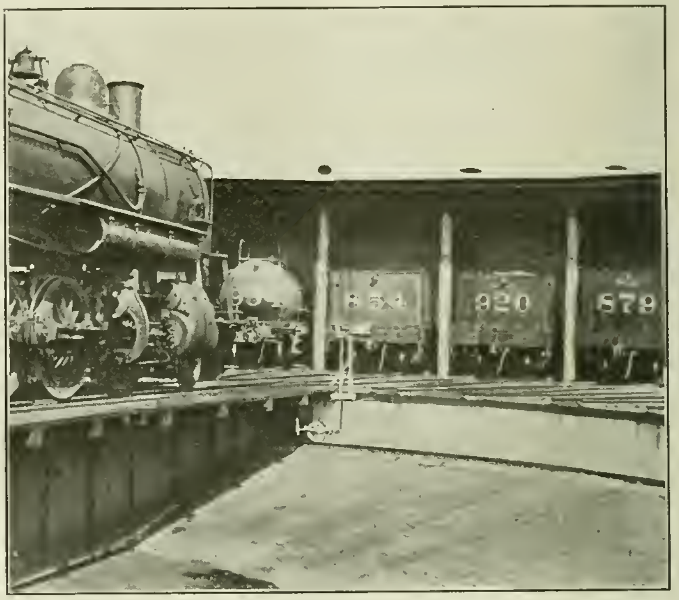


Fig. 2—The Construction of the Indicator Is Evident from This View

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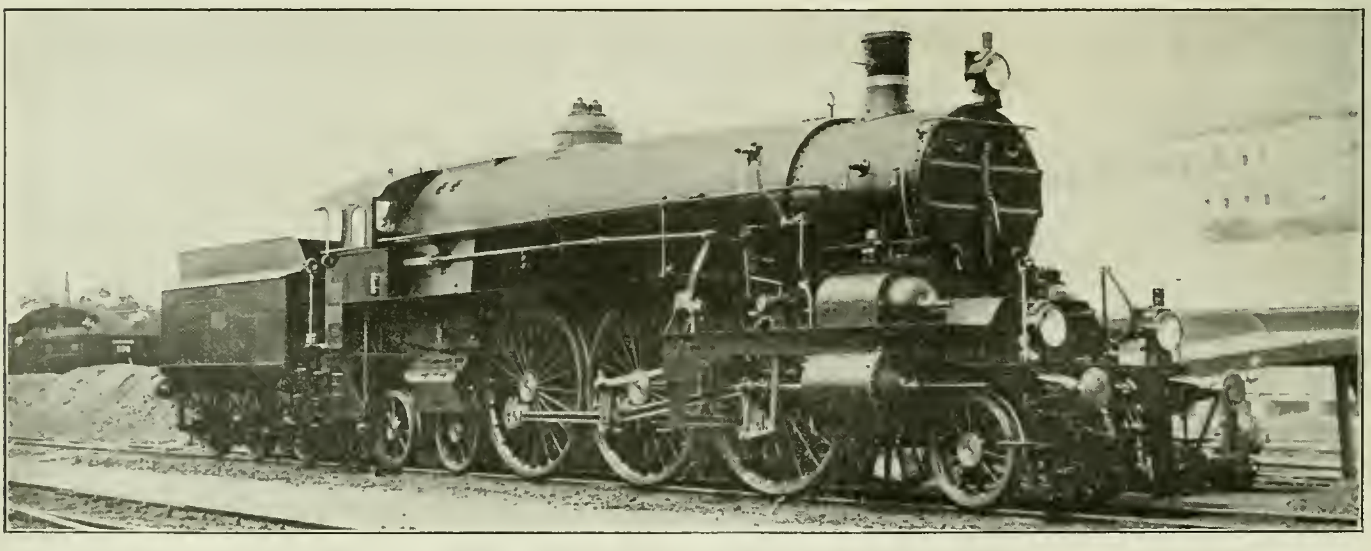
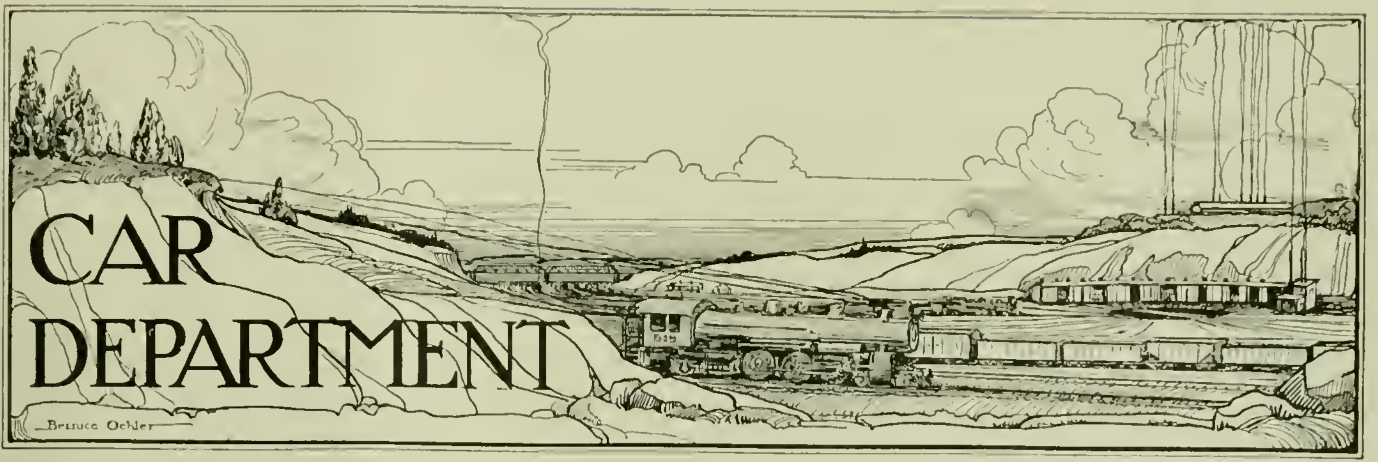


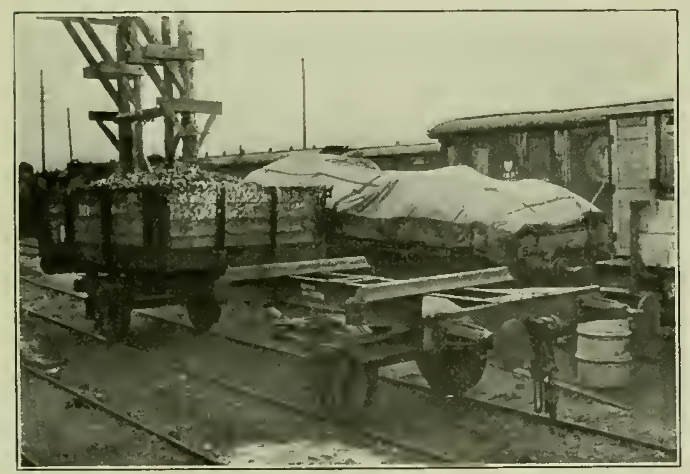
An Austrian Compound, Superheated Passenger Locomotive



Container Cars in Use in Poland

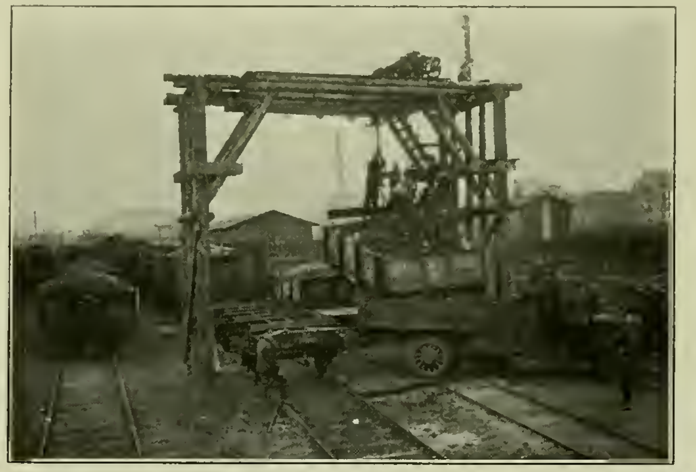
An interesting modification of the container type of car, designed for all classes of freight service, has recently been built by S. Rodowicz of Warsaw, Poland. The new construction is similar in principle to the cars that have been used to a limited extent in this country, though of more general application. The design provides an underframe equipped with trucks which can be utilized for hauling any type of superstructure, as open-top box, closed box, platform, tank, etc. The superstructures are interchangeable on the underframes and being removable can be transported without unloading and reloading from origin to destination, whether the shipment moves over standard or narrow gage railroads, by truck or by boat.

The construction of the cars is plainly shown in the drawings and photographs. The underframe is built integral with two two-wheel trucks and has a substantial center sill and end sill fitted with couplings and buffers. Extending across the underframe are crossbearers, to the upper side of which are fitted pressed steel members of trapezoidal cross-section. The transverse beams in the bottoms of the bodies are spaced so as to fit accurately over the crossbearers, preventing longitudinal or lateral movement between the body and the underframe. One of the photographs shows the underframe fitted with two bodies, one of which has been removed. The second photograph illustrates the manner in which a dump body can be removed from the car and unloaded directly into a motor truck.



Container Car with One Body Removed Showing Details of Underframe

It is believed by using this type of car the investment in equipment can be reduced materially as a single underframe is sufficient for three complete superstructures. While one body is in transit on the underframe one will be loading and another unloading. By decreasing the number of units it is possible to make each unit of the most approved construction, provided with continuous brakes, without increasing the investment required to handle a given tonnage. This in turn will make it possible to increase the speed of freight trains and thereby improve the performance of the individual cars.



Dumping the Load from a Container Car Onto a Motor Truck

Henry Ford Comments on Car Design

In an interview published in a recent issue of The Nation's Business, Henry Ford stated some of the methods whereby he intended to improve the operation of the railroads. As his criticisms of car design are of special interest, that section of the interview is given in full below.

"The second step would be to remove the great physical burden of the railroads—needless weight of rolling stock. Overweight of rolling stock is the prime mistake on the mechanical side of railroading. Engines and cars are four or five times as heavy as they should be. A freight train is several times the weight of the load it carries, and a passenger train is 20 times as heavy. This dead weight must be moved whether a train is loaded or empty. The cost of pulling empty trains is needlessly large. Contrast this with the efficiency of the bicycle which weighs 20 lb. and will carry a man who weighs 200 lb."

"It is contended," the interviewer suggested, "that weight is necessary to make railroad cars hold the track."

"Were you ever arrested for speeding?" Mr. Ford countered. "If so, the cop who overhauled you was mounted on a motorcycle that weighed about one-tenth as much as your car, yet it was speedier than you were. The problems of holding the rails can be taken care of in redesign.

"Here is an example of redesign in freight cars. The axle of a car and the two wheels upon it operate as a unit almost as though they were one piece. When the car goes around a curve one wheel has to travel farther than the other. Since they are on the same axle and one cannot turn without the other, this makes it necessary that one wheel should slip on the rail. There are theoretical compensations which it is claimed take care of this difference of distance traveled by wheels, but they are not real compensations. The axle connecting these wheels must be very strong to force the slip. To secure this strength the axle must be very thick and heavy.

"What we have set out to do is to design an axle that will allow for this difference in the distance the wheels have to travel, that will make the slip unnecessary. We have already solved the problem. But in doing so we have greatly reduced the weight of the undergear of every car.

"We are not governed in our redesign of rolling stock by what has gone before. We are going to make some revolutionary changes. We find that the present types of rolling stock can be greatly improved. On the Detroit, Toledo & Ironton we are using up the old types of engine and car, but they will be displaced by better types. We will patent our new designs where they are patentable, but we will do this only to prevent someone else from doing so. Some patents are taken out to prevent the free use of ideas. Our patents will guarantee the free use of ideas. We will never proceed against anybody for infringement of our patents. They will belong to the world. Anybody who wants to can use any improvement we make. The Ford organization has never proceeded against anybody for infringements of its patents.

"Great weight in trains, of course, calls for correspondingly heavy rails and ties. The producers of iron and steel have had much to do with the development of railroads. The heavier the engine and the heavier the rail, the greater was the consumption of steel and the greater profit all along the line. The builders of rolling stock have regarded, or have pretended to regard, size as an evidence of advancement. They have long ago passed the point of economy."

"It is said, Mr. Ford," I interjected, "that your claim of the economy of lighter rolling stock is an undemonstrated theory. How do you know that it would be more economical?"

"Well," he replied, "it doesn't do much good to talk about it. Anything that one can say is open to dispute or denial, but whatever one actually succeeds in doing is beyond argument. We have a pretty clear idea of what we are going to do. Once it is done, it won't need any explanation. However, you have got hold of the main principles. We are hauling around too much dead weight. It costs money to do that. The public has got to the point where it cannot pay for dead weight and live freight, too. One or the other must go.

Unnecessary Transferring of Loaded Cars

In a recent issue of the *Railway Age*, F. W. Brazier of the New York Central makes the following comments on present interchange practice:

"The question of unnecessary transferring of loaded cars has been discussed for years and no real action taken to stop the large number of cars from being transferred. The remedy I would suggest is one that would cut down at least 50 per cent of the so-called transfers, if it could be put into effect.

"It is not the fault of the car inspector who cuts out a loaded car for transfer that in his judgment is unsafe to run. Furthermore, I do not think any railroad today would stand for a vindictive car inspector cutting out cars unnecessarily. Our operating officials were greatly alarmed over the large number of cars that were being cut out for this purpose and wanted me personally to inspect cars at different points to see if the inspectors were justified in cutting them out. In almost all the cases I found the condition of the cars was such that the inspectors were justified in doing so. My greatest surprise was in many cases that the cars ever reached our terminals in such bad condition, being not only unsafe to run but unsafe for the lading.

"I could go into considerable detail but will simply give the following figures taken recently from our records for a period of 30 days: Cars cut out numbered 803; of these 750 were foreign cars. Of these cars 157 were all-steel or steel underframe with defective underframes and sills. Of the remainder, 502 cars had wooden sills, broken draft timbers, burst ends, etc., and the balance of the defects were broken hoppers, bulged ends and defective trucks. A large percentage of the cars were of light construction and must have been in bad order when they were loaded.

"The remedy is that no car should be loaded at a terminal that is not first inspected by a competent car inspector as to its fitness for the lading intended to be carried in it; it should also be inspected for the condition of the running parts.

"Some few years ago the MCB Association proposed that all cars should be inspected and carded for the kind of lading they were intended to carry, but no final action was taken as it required the co-operation of the transportation department. If the railroads would take some action to this end it would soon bring out the fact that there are many thousands of cars not fit to carry ordinary freight unless they are repaired before loading.

"It is true that cars have been known to be transferred and sent back to the receiving line; that no repairs were made and the cars were again loaded with freight and sent forward by a different road. Many cases have been brought to our attention where we have been offered the same car on which no repairs had been made; these we have rejected and cut out the second time. Then again in some cases on the first transfer of the car it was loaded with grain and in such a condition that it could not be repaired; it was transferred and sent back to the receiving line, where it could be loaded with lumber or bricks and be safe for that class of lading.

"The A. R. A. rules have defined what class of repairs should be made to cars under load so as to save the expense of liability of damage to freight in transfer, but it is utterly impossible in many cases to carry out A. R. A. rules and make repairs to cars under load, and consequently transfers must be made to save delay.

"Another point that should not be overlooked is that during federal control where cars were home on any railroad, we had a great many light capacity cars running over the system that never should have been allowed away from their home road. Until such time as the railroads can get their cars in first class condition and take more care in inspection before loading, we will continue to have numerous cases of transferring of loads . As suggested above, proper inspection of equipment before it is loaded will stop 50 per cent of the transfers."

Franco-Canadian Exhibition Train.—To advertise the life and industries of France, a traveling exhibition, occupying eight cars, was recently shown in the principal cities of Canada. Its itinerary included Montreal, Three Rivers, Quebec and Toronto. The eight exhibition coaches were assigned as follows: First coach, "La Pensee Francaise" (The French Thought), which included some of the finest treasures of French art and literature, as well as relics of the wars of France. Second and third coaches: Industrial exhibits, including travel, photography, civil engineering, mines and mineral products, mechanics, etc. Fourth coach: "La Mode," including dresses, silks, laces, etc. Fifth coach: Leather industries, chemical products, drugs, perfumes, electrical appliances, brushes, toys. Sixth coach: Agricultural, horticultural and alimentary products. Seventh coach: Decorative art, bronzes, watches and clocks, jewelry and cutlery.

One of the New Sleepers Leaving Angus Car Shop

New Sleeping Cars for the Canadian Pacific

Composite Cars of 12-Section and Compartment Types Have Special Facilities for Comfort of Passengers

In handling its through passenger business the Canadian Pacific is confronted with some interesting problems. The road has the advantage of a fine scenic route and with a line extending from coast to coast, is well situated to secure transcontinental passengers. On the other hand, the competition for Pacific Coast traffic is very keen. Furthermore, the prospect of the journey of 2,886 miles between Vancouver and Montreal, requiring four and one half days to complete, might seem unpleasant to inexperienced travelers. The hotels conducted by the company at intervals along the route afford an opportunity for breaking up the journey, but even so the character of the traffic demands that the passenger equipment be of the highest grade, provided with every facility for the comfort of travelers. These conditions were carefully considered by the railroad in drawing up the designs of the latest order of 12-section and compartment sleeping cars. As a result the cars have been fitted with numerous conveniences not found in the ordinary sleeping car.

Interior of the Twelve-Section Sleeper

One of the notable features of the 12-section type sleeping cars is the provision made for the comfort of women passengers. This is particularly desirable in the transcontinental service on account of the length of the runs and because the proportion of women in tourist traffic is greater than where the cars are used principally for business trips. The ladies' dressing room is unusually commodious. It is fitted with three wash stands, each of which has a light above it, and is provided with a three panel, adjustable mirror. A long mirror is also fitted in the saloon door. One of the innovations which should contribute materially to the comfort of women passengers is a couch which has been installed in the dressing rooms on some of these cars. This provides an opportunity for relaxation that would seem highly desirable in view of the somewhat uncomfortable form of the usual sleeping car seat.

The new equipment consists of 69 sleeping cars, 56 of the 12-section type and 13 of the 10-compartment type. All the cars are constructed with steel frames and wood interior finish. The frames and trucks were built by the Canadian Car & Foundry Company at Montreal and the interior fittings were applied at the Angus shops of the Canadian Pacific.

On account of the special features of the design, the 12-section sleeping cars are extremely long, the length over the body and sills being 75 ft. 6 in., and the coupled length 83 ft. 10½ in. The truck centers are spaced 59 ft. 6 in. apart and the wheel base is 70 ft. 6 in. The height from the rail to the top of the roof at the center is 14 ft. ¾ in. and the extreme height, from the rail to the top of the heater jack, 14 ft. 6½ in. The width at the eaves is 10 ft. 1½ in. and over the side sheets 9 ft. 10 in. The average weight of the cars is 173,400 lb.

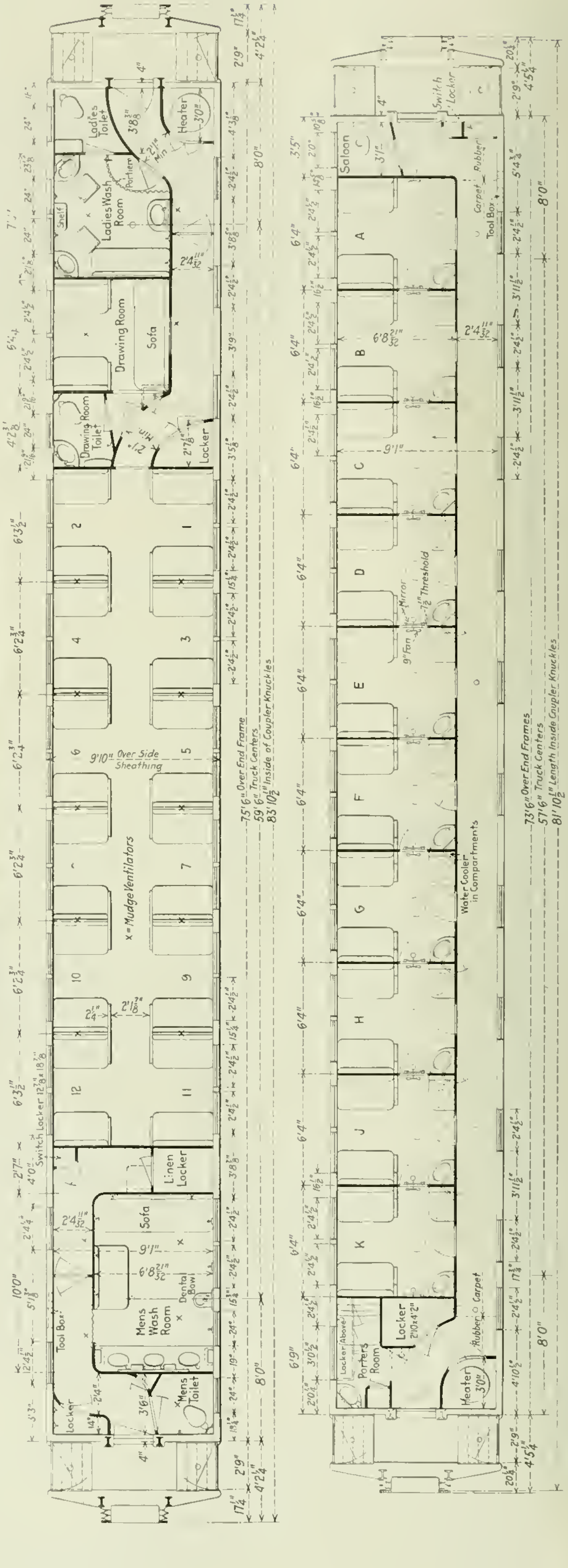
The underframe is built with a deep fish belly center sill and Z-bar side sills. The center sill has a maximum depth of 30 in. between crossbearers for a distance of 28 feet and is 15 in. deep at centerplate. The web plates are 5/16 in. thick and are spaced 16 in. apart. At the bottom they are reinforced by two 3 in. by 3 in. by ⅜ in. angles on each plate, while the stiffening at the top consists of one 6 in. by 4 in. by ⅝ in. angle placed outside each plate with the short flange horizontal. A top cover plate 30 in. wide by 9/16 in. thick extends continuously for practically the full length of the sill, the ends reaching just beyond the door posts.

The body bolsters are of the double type commonly used with six wheel trucks, of built up construction, the two arms being 4 ft. 8 in. apart. The cross bearers, which are spaced 15 ft. 9 in. from the center plate, are also built up of pressings reinforced with angles and top and bottom cover plates, the construction being shown in the cross sectional drawing. The floor beams are pressed from 5/16 in. plate, the spacing varying from 16 in. to 3 ft. 1⅜ in. The side sills are each made up of a 5 in. 11.6 lb. Z-bar and a 3 in. by 2½ in. by ¼ in. angle. The body end sill is a 5/16 in. pressing. An end cover plate, 5/16 in. thick and 22 in. wide, extends across the underframe at each end. At the bolsters there are also ¼ in. by 5 ft. 6 in. by 8 ft. 11 in. cover plates. The remainder of the floor is covered with 1/16 in. floor plates, which overlap the centersill cover plate on each side and fit over the floor beams and side sill.


The Dressing Room Is Designed to Insure Comfort for Women Travelers

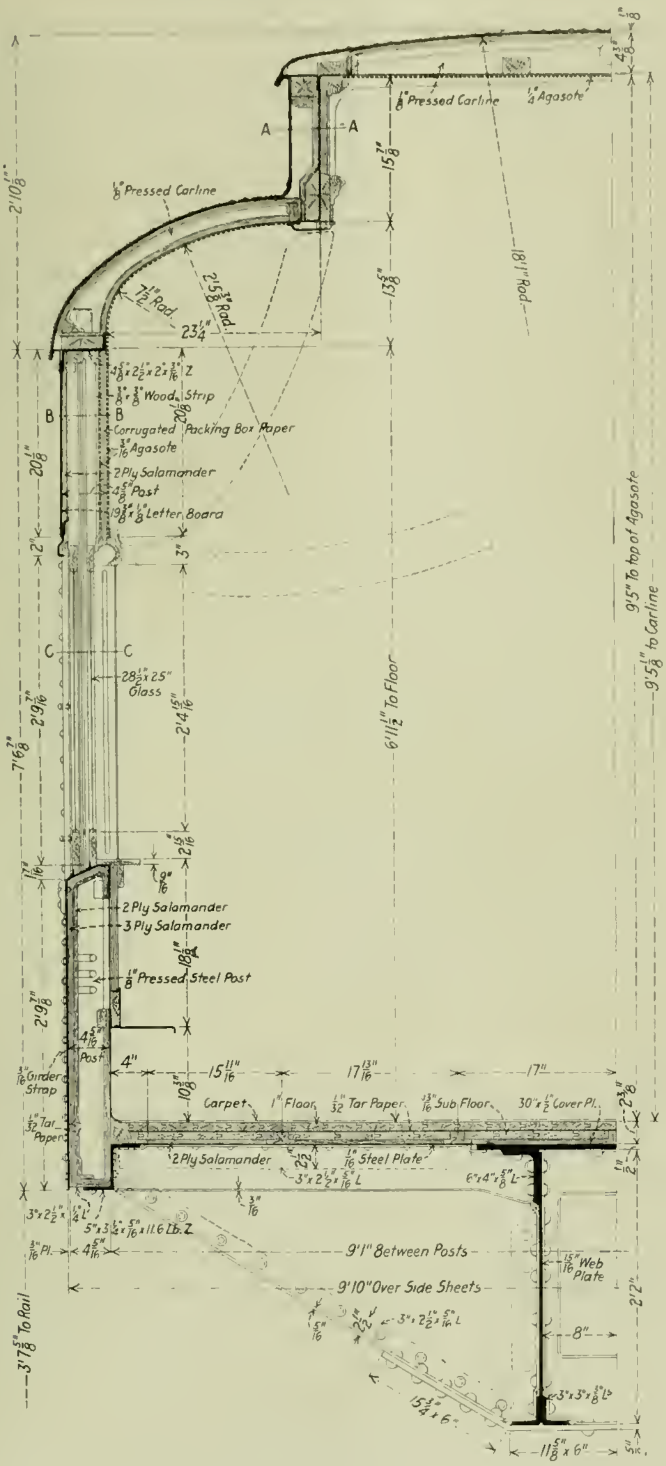
Side Frame

The side posts are of two types, those at the piers being of U-sections made right and left, the sheets being riveted to the flanges. The center pier posts are of a deeper U-section, the web being turned toward the outside of the car. The side plate is a Z-bar, 2 in. by 2½ in. by 4⅝ in. by 3/16 in. and is made continuous from end to end. The carlines are pressed of ⅛ in. steel. The lower carlines, which are continuous across the lower deck and up the side of the clerestory, are of ⅛ in. steel plate of U section, irregularly spaced at intervals of about two feet. A Z-shaped deck plate ⅛ in. thick is



Floor Plans of the Twelve-Section and Ten-Compartment Cars

fastened to the inside of the clerestory. The upper carlines are of ⅛ in. steel of Z section, 4⅜ in. high at the center and are placed directly above the lower deck carlines wherever possible. They are riveted to the inside deck plate and to the lower carlines. The body corner posts are built up of a 3 in. by 4 in. angle forming the corner with a 4 in. by 3 in. by 3 in. Z-bar riveted to the inwardly extending flange of the angle and forming a point of attachment for the end plates. The door posts are 6 in. I-beams to which wooden door frames are fitted. There are two intermediate posts on each side made up of 4 in. by 3 in. by 3 in. Z-bars, reinforced up to about two feet above the floor by 3 in. by 3 in. angles. The vestibule diaphragm posts are of 6 in. I-beams and are braced to the end posts of the body by 6 in. channels. The vestibule corner posts are made up of pressed steel with a wood filler.



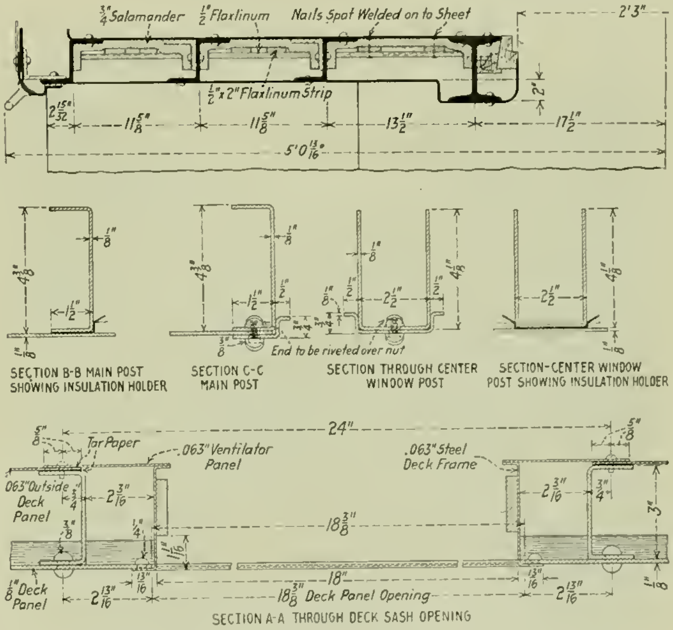
Transverse Section Through the Car Body

The outside plates below the windows are 3/16 in. thick and meet the window ledge under the belt rail. The letter board and the pier plates are ⅛ in. thick and the outer deck plates 1/16 in. thick. The roof sheets are 1/16 in. thick excepting the hood sheets, which are No. 12 gage galvanized.

The exterior of the cars is finished in Tuscan red, the railway company's standard colors.

Interior Finish

The fittings in the interior of the car have been designed to give a pleasing appearance and also to afford adequate insulation for the extremely cold weather encountered in Canada. Three thicknesses of insulation are used in the side walls and two thicknesses in the roof and the deck. The method of fastening the insulation in the deck is worthy of mention. Wire nails are attached to the sheets by spot welding the heads. The insulation is driven over the nails which are then bent over. The floor has one layer of insulation over which a double wood floor is laid, except in the passageways which have rubber floors and the saloons where tile is used. Steel plates form the inside of the wall up to the seat level and a third layer of the Salamander insulation is carried up to that point. The inside of the walls above are covered with wood wainscoting up to the lower edge of the berths. The side walls within the berths and the headlining are of Agasote. The berths, the deck molding and the interior partitions are of wood.



Horizontal Sections Through the Car Body

All the woodwork is mahogany or mahogany finished, except in the men's smoking room where either English oak or black walnut has been used. All parts above the deck molding are painted greenish gray. Little ornamentation is used. The ceiling and deck panels have a conventional border and marquetry borders are set into the berths and bulkheads. The seats are upholstered in green figured friezette plush and the carpet also is green. In the staterooms Biltmore plush is used for upholstery.

The men's smoking compartment has three wash basins, a dental lavatory and seats for six persons, upholstered in leather. The entrance to the men's saloon is from the hall instead of through the smoking room.

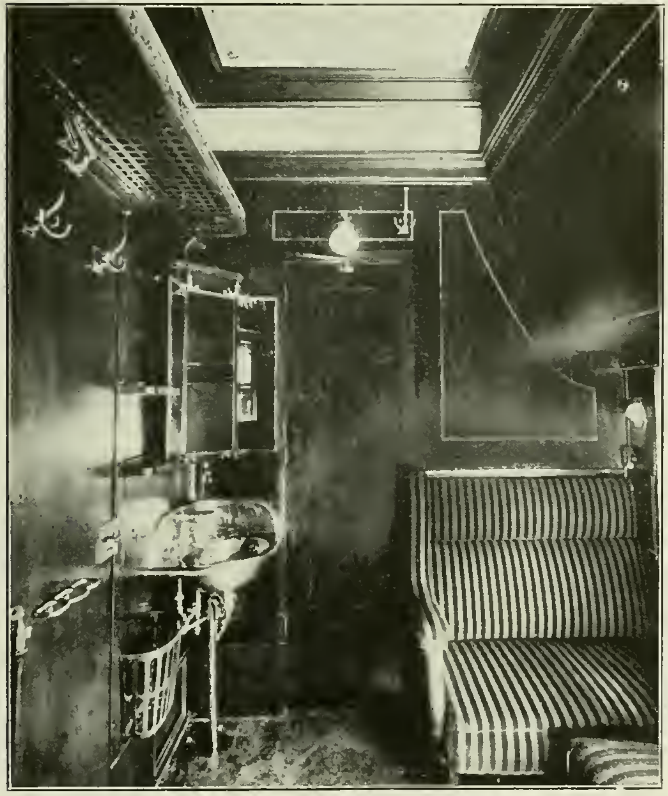
The cars are heated by a combined vapor and hot water system with a Frumveller heater. The main piping has separate controls for each side of the car, for the stateroom and the smoking and dressing rooms. Additional heating pipes are provided which have individual regulation for each section. Twenty-one Mudge ventilators are applied to insure adequate air circulation.

The lighting systems are of the Safety and Stone-Franklin types. The batteries have a capacity of 600 ampere hours. The main lighting fixtures have semi-opaque bowls, five of this type being used over the berths and one in the stateroom. The usual arrangement of small lamps in the berths and aisle night lights is followed. The smoking room is fitted with a two-light ceiling cluster and individual lamps over the mirrors, while in the ladies' dressing room wall fixtures only are used. The conduits for the piping are set inside the walls and the roof.

The cars are carried on Commonwealth six-wheel trucks, with 5 in. by 9 in. journals, having a wheel base of 11 ft. They are equipped with steel tired wheels and clasp brakes. The brake equipment is the schedule LN1812 designed for 90 per cent braking power. Miner hand brakes are used with a sheave wheel between the drum and the brake rigging to increase the force.

Compartment Cars

In general design the compartment cars are quite similar to the 12-section sleeping cars. The body is two feet shorter and changes have been made in the spacing of posts to fit the altered floor plan. The interior woodwork is mahogany and the upholstery is Biltmore plush. Care has been taken in fitting the compartments to afford the maximum of comfort and convenience for the passengers. Individual regulation of heat and ventilation is provided. A long baggage rack, an umbrella rack, trays and numerous hooks are facilities that will appeal to the traveler with a large amount of luggage. Space at one end of the car has been utilized for a saloon while the other end carries the heater, linen locker and porter's room.



Interior of One of the Compartments

Both types of cars are equipped with safety appliances to meet the United States and Canadian standards. The handholds are attached so that they can be removed without disturbing the car framing, flooring or lining. Other appliances include bottom operating lower couplers, Miner A5P draft gear, Acme single web type diaphragms with rubber hoods, JM expander rings, Miner buffer and Woods single roller side bearings.

Coopering Cars for Grain

E. F. Ford, freight service inspector of the Chicago, Burlington & Quincy, has prepared some useful suggestions to grain shippers, calling attention to the need for careful inspection and preparation of grain cars, particularly at this time when over $4,000,000 out of a total of $6,000,000 paid out in loss and damage claims to grain, represents shortages resulting from causes other than wrecks. Mr. Ford says:

It has been our experience that grain can be moved/practically without leakage by the right kind of teamwork on the part of shipper and railroad agent. Our statistics show as many as 100 to 200 cars from a certain station forwarded without a claim, while a nearby station forwarded half as many cars and had several claims, both stations being on the same railroad and the empty cars allotted by the same car distributor and set to elevators by the same train crews.

Investigation of such cases invariably develops that at the station having such good results, there is teamwork on the part of shipper and railroad agent in the inspection and coopering of cars, while at the station having unsatisfactory results we find there is little or no co-operation between shipper and agent. The local will set out an empty car, and if the agent sees a "Fit for Grain" tag on it he has it set for loading, shipper does what he regards a good job of coopering and the car is loaded. Three heads are better than one, and if the shipper would request the railway agent to look the car over after it has been coopered, in many instances defects which escaped the previous inspection would be discovered.

A shipper should not assume that a car is fit for loading simply because a "Fit for Grain" tag is on it. Car inspectors, like the rest of us, are liable to error. The safest course is for the local agent and the shipper to carefully inspect the car before loading regardless of the tag.

Reject any car with weak or broken door or end posts, leaky roof, creosote or oil-soaked floor, or if it is an old car which in your judgment cannot be made grain-tight by a fair amount of coopering.

Look carefully for cracks at side walls caused by short floor boards and cover tightly with paper or burlap, cleated.

Cover tightly in the same manner all defective places found in car lining, being particular to cover with tight fitting boards end-door openings.

King pins and draft bolts should be covered and cleated.

Grain lining at top and belt rail should be carefully inspected and where not absolutely grain-tight it should be made so by use of paper or burlap calking.

Place paper pads tacked to door post to give smooth surface and tight fit to grain doors, which should be nailed with 12d nails two to each end of each grain door. This is important, since experience proves that 12d nails are the exact size required for safety—this nail gives 1¼ in. penetration into the oak door post and will hold the door in its place through any rough handling car might encounter. Smaller nails give trouble and larger nails require chopping out and destruction of grain door at unloading point.

Cover with paper all grain door cracks and where loading heavier than 60,000 lb., reinforce with an extra door across joints between first, second and third door joints.

Go over the outside of car and securely fasten with cement-coated nails any loose sheathing boards you may find.

Prevent any possible leakage where sills have rotted by using burlap nailed to bottom of sill and secure sheathing by nailing a strip of board over it at the rotted sill.

Make Car Owners' Responsibility Complete*

Reduce Handling Line Liability Under Interchange Rules—Include a Profit in Billing Prices

BY C. J. WYMER
Superintendent Car Department, Chicago & Eastern Illinois

SHOULD not the present A. R. A. Interchange Rules be revised to eliminate dual responsibility, making car owners responsible for all defects?

This should be qualified to the extent that it might be desirable to make the handling line responsible for extensive accident damage and departures from important standards on foreign cars. It would be desirable to maintain a limit of repairs requiring the authority of the owner to prevent a greater repair expense than he might wish to make on certain equipment.

The present interchange rules make a division of repairable defects as between owning and handling line responsibility, many of which, in our opinion, are of such minor importance as not to justify the attention they require properly to place the responsibility as defined. Furthermore a very large majority of the defect cards which are issued in interchange are for old damage, indicating that the penalty it is supposed to inflict as punishment for what, under the rules, is considered the misuse of equipment, does not assess against the guilty party. Our conclusion is that punishing the innocent does not decrease crime.

Some have argued that it is essential to have handling line defects as a means of avoiding useless damage to equipment through rough handling by switchmen and train crews, believing they are more careful when handling foreign line equipment than they would otherwise be on account of the liability for certain damage being assessed against the employing company. But the foreign car is handled along with the home car and any effort to give the home car preferred handling would result in the foreign car receiving the same treatment. Then, again, the average train man does not know where the lines of responsibility are drawn, if he even knows they exist at all, and he is interested in numbers and initials of cars only for the proper movement of them in line with his duties.

The first interchange rule reads as follows: "Each railroad is responsible for the condition of all cars on its line, and must give to all equal care as to inspection and repairs, regardless of responsibility for expense of repairs." May we ask what is the intent of this requirement of the rule and whether it is performing its function? It is clearly the intent of the rule to require that a car be maintained for service while on foreign rails equally as well as it would be on its home rails. We do not believe that any concrete argument need be presented in support of a statement that the rule is not complied with, as it is a well-known fact that most cars, if they are away from their home rails for an extended length of time, return as cripples if they return at all.

Accepting the above statement as a fact as to the intent of the rule and also as to its ineffectiveness, the next questions most natural to arise are, "Why is it not effective?" and "What right has it to exist?"

It has a perfect right to exist because it is correct in principle, and if the money which it costs the railroads annually for the movement over their rails of foreign equipment in bad order because it was not maintained away from home and not sufficiently maintained at home, could be known it would be a surprising amount. Added to the other vast amount which would be saved in claims arising from improperly maintained equipment, it would be sufficient to cause every railroad man to do his part in overcoming this needless expense.

It may be argued with some merit that the owning road is best equipped for repairing its own cars since it is supplied with material peculiar to their construction. Admitting that this argument has some value, represents only a small part of the upkeep of the equipment if the "stitch in time" were applied; and, again, when we find that materials common to all railroads are not maintained, we are forced to conclude that it is not of prime importance. If railroad cars were constructed along more uniform lines in certain details, this objection would be practically removed, and a large reduction in material supplies on hand could be made.

There is lack of adequate incentive to act as Rule 1 requires. Outside of defense of home and country, it is natural for mankind to expect some material reward for service rendered, and the way to create this incentive would be to revise the A. R. A. Rules to the extent that they would represent a substantial profit for material and labor expended in making repairs. Were this done, it is our belief that it would not only have a far-reaching effect in securing prompt repairs to foreign equipment, but would cause a better maintenance of the home cars. The handling line would be willing and anxious to repair foreign cars on account of the profit to the company, and would be equally anxious to maintain its own equipment in such manner as to require the minimum attention in the way of repairs while away from home to prevent paying a premium to other railroads for their maintenance. It would result, further, in better initial construction in order that cars would perform their service with the minimum amount of repair attention during their existence. It has too often been true that substantial construction has been sacrificed to reduce initial cost.

There are still further benefits which should be derived from the proposed changes in the way of labor and stationery saving. The inspection forces now employed at interchange points for making technical inspection and records to conform to the intent of the rules could be greatly reduced, and this wasted labor, made necessary on account of present rules, diverted to the actual repair of equipment. Much time is consumed by officials, who are responsible for their enforcement, in an effort to familiarize themselves and their employees with the requirements of the rules which very consistently change at least once each year. There is a constant flow of correspondence over the railroad and with other railroads on account of the dual responsibility of the interchange rules, which would cease, thus saving much time of officials and clerks as well as stationery. These energies could be directed with better results along constructive lines.

Inspection of equipment in our judgment, should be confined to the determining of three conditions: (1) To insure safe movement on the railroad; (2) To insure safety for train men, and (3) To provide for the protection to commodities.

With delivering line responsibilities eliminated the inspection at interchange points would much better conform to the above requirements and the work be performed with greater dispatch. At present, special effort is made to locate

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*Abstract of a paper read before the Western Railway Club, Chicago, October 17, 1921.

whatever delivering line responsibilities the car may carry, which may be only a few raked side sheathing that in reality only mar rather than disqualify a car for service. More serious defects, such as worn-out wheels, defective brake beams, etc., that may cause an accident resulting in the destruction of many dollars' worth of property and possibly the loss of human lives, are overlooked. The movement of cars is often retarded at interchange points, delaying shipments and creating switching expense, which would not occur if there were but one responsibility, *i. e.*, car owners'.

The above-outlined plan could not be put into effect in fairness to car-owners without giving full consideration to their interest in the way of an adequate rental charge for the use of their equipment while on foreign lines. This consideration would be an absolute necessity in connection with the other changes suggested and without it it would mean great sacrifices to present and future owners of large amounts of equipment. It would also be necessary for the purpose of encouraging the ownership of equipment, as it can be readily seen that with the repairs placed on a profit basis and the rental charge for the use of equipment low, it would be to the advantage of any railroad to own just as few cars as essential to the conduct of its business over and above the equipment it was able to obtain from other lines. Furthermore, there would be no disposition on the part of such railroads to release equipment as long as it could possibly be made use of to advantage.

A high rental charge should also have the effect of moving equipment to the home line during depressions in business. The rental charge for the use of equipment should be sufficient to return to the car-owner during the life of his equipment the original investment, maintenance cost and other expenses incident to ownership, and a fair interest return.

Private owners of equipment might consider that the plan suggested would work a hardship on them on account of having no opportunity to participate in the repairs of equipment belonging to other companies, but they would be fully protected if a suitable rental charge for the use of their equipment were provided.

We are not in a position to say what would be the proper labor, material and rental charges to carry out the plan outlined. If considered favorably, a thorough investigation of the subject would be required by competent accountants to arrive at these charges properly.

We appreciate, with repair forces reduced to a minimum on all railroads, and considering the present general condition of all equipment that no substantial progress could be made in bringing about a radical improvement in the present condition of cars, without increased application of labor and material. But some of the advantages of the plan suggested would immediately accrue without any attending disadvantages, and it is hoped that present conditions will not always exist. When conditions do become favorable, the benefits of the plan would become effective in all the various channels outlined. These recommendations represent rather radical changes from present methods, but we believe that these or other changes no less radical are essential to bring about a more substantial maintenance of equipment and the cutting loose from expensive red-tape systems, and will eventually come—so why not now?

A Check on Rough Handling of Cars

Road service tests on a device designed to keep a record of the rough handling of cars have been carried to the point which is said to have definitely established the practicability of the device. They have also shown that most of the rough handling to which cars are subjected occurs in yards during the makeup and breakup of trains and not, as has been claimed by some, in the handling of trains on the road as a consequence of slack adjustments. The particular value of this device arises from the possibility of effecting an appreciable reduction in rough handling.

The device consists of a spring motor or clock which winds a tape or registering chart graduated to 15-min. periods and designed to give a continuous record over a period of 10 days. This tape records the movement of a pencil attached to a weight which moves between suitable guides under the control of two springs. Any sudden impulse or impact given to the device gives the weight a vibratory motion and thus records marks in a crosswise direction on the tape. The length of these lines, as indicating the distance that the weight has been moved from the neutral position near the center of the tape, is a measure of the amount of impact sustained.

The first problem which it was necessary to settle before a successful test could be inaugurated was that of determining the limit of rough handling in terms of vibration on the chart of the impact register. This was accomplished through a series of tests conducted with a view of creating actual cases of rough handling and observing the resulting vibration on the chart of the impact register. Both loaded and empty cars were used, with wood and steel underframes. These were allowed to couple at speeds varying from 2 to 10 miles an hour. Each case was considered from the standpoint of possible damage to a car of merchandise and was accordingly adjudged as being a case of rough handling or permissible handling and the limit of rough handling was decided to be between two and three miles an hour speed at the time of impact.

After the chart graduation test had been completed, a number of machines were put into use in through merchandise cars operated by the Chicago, Milwaukee & St. Paul between Chicago, Kansas City, Milwaukee, Madison, Minneapolis and Mason City. The machines were in cars operated on a regular loading schedule and were handled at destination by the agent in charge. No traveling inspector accompanied the machines, but their records were removed by the receiving agents and mailed to the general office for investigation and tabulation. The movement of the machines was not advertised and train crews did not know at any time when they might be handling the register. Each case of rough handling which resulted was taken up with the superintendent on whose division it occurred and the crew responsible disciplined therefor.

Studies of records made with the increment recorder indicate, as stated in the opening paragraph, that 97 per cent of the rough handling cases actually occur in yards. The question has been raised whether it is within the limits of reason to expect that cars may be handled under the conditions imposed on railway operation without a certain amount of rough handling. In answer to this it is noted from the record obtained in the tests that 27 out of 111 cars under observation moved from origin to destination over an aggregate distance of 10,000 car miles without a single case of rough handling. There are also repeated instances where cars moving over exactly the same route received widely varying treatment. It is, therefore, estimated that if 24 per cent of the cars can be handled properly under present conditions of transportation with no rigid disciplinary measures in effect, the enforcing of proper discipline would enable the handling of at least 70 per cent of the equipment in the same manner. The impact recorders described above were developed and are being manufactured by the Railway Impact Register Company, Belleville, Ill.

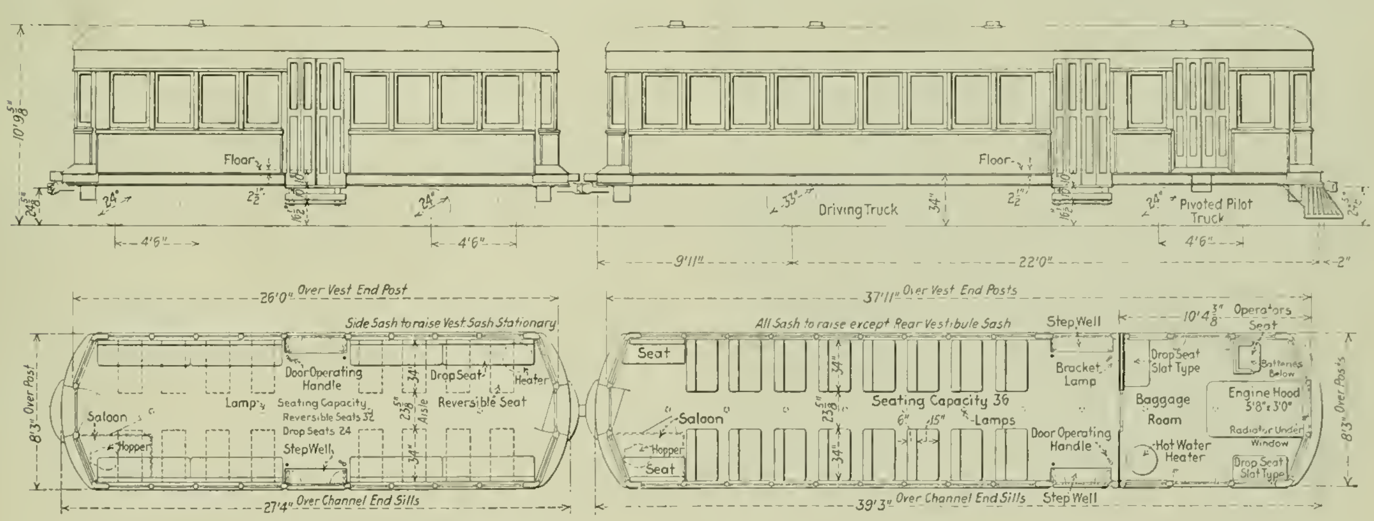
Anti-Railway Propaganda in Italy.—An Italian journal is reported as estimating that if the 200,000 railway workers of that country were each employed in driving 10-ton trucks 8 hours a day for 300 days a year, five times as many ton miles would be carried as by the Italian railways now. The number of employees necessary for repairing trucks and for loading and unloading freight are not mentioned.

One of Three Bowen Motor Cars Recently Delivered to the Pittsburg & Shawmut

Bowen Gasoline Motor Driven Passenger Car

Arrangement of Power Transmission System and Rear Truck Are Features of Design

A GASOLINE motor driven passenger car particularly adapted for use on branch or short line steam railways, which involves a unique combination of standard automobile practice with the essential features of railway rolling stock design, has recently been developed by the Bowen Motor Railways Corporation, St. Louis, Mo. The car shown in the illustration is one of three for the Pittsburg & Shawmut, the construction of which was recently completed by the Barney & Smith Car Company. The features of construction of particular interest in this car are the arrangement of the power transmission system and the design of the rear truck, through which the power is transmitted to the rail.



Elevation and Floor Plan of Motor Car and Trailer

The power plant is a four-cylinder automobile motor with 4½-in. by 6-in. cylinders, capable of developing 62 brake horsepower at 1,600 revolutions per minute, which is attached directly to the underframe. From the motor clutch, which follows the lines of automobile practice, power is transmitted by means of a longitudinal shaft to the main transmission, which provides for four speeds. The ratio of shaft speed at the driven and driving ends of this transmission vary from 4.99 to 1 for the first speed to 1 to 1 for the fourth or high speed. From this transmission power is again transmitted through a longitudinal shaft to an auxiliary reversing transmission, which provides a speed ratio of 1 to 1 in forward motion and of 1.085 to 1 in reverse. From this transmission to the rear axle gear case power is again transmitted by a longitudinal shaft.

The cast steel gear housing of the rear axle is built in two sections to permit easy inspection and repair of all gears and pinions. This construction makes it unnecessary to disassemble the truck in case any gears are to be removed. The arrangement of the combination bevel and spur gears is such that the gear ratio of the drive and, therefore, the car speed can be changed at any time by replacing the bevel gear set by another of a different ratio. From the motor to the rear axle gear case the transmission devices and shaft connections throughout follow standard automobile practice, the details conforming to the standards of the Society of Automotive Engineers.

Compressed air to operate the brakes is provided by an air compressor mechanically driven by a longitudinal shaft from a power take-off located at the main transmission.

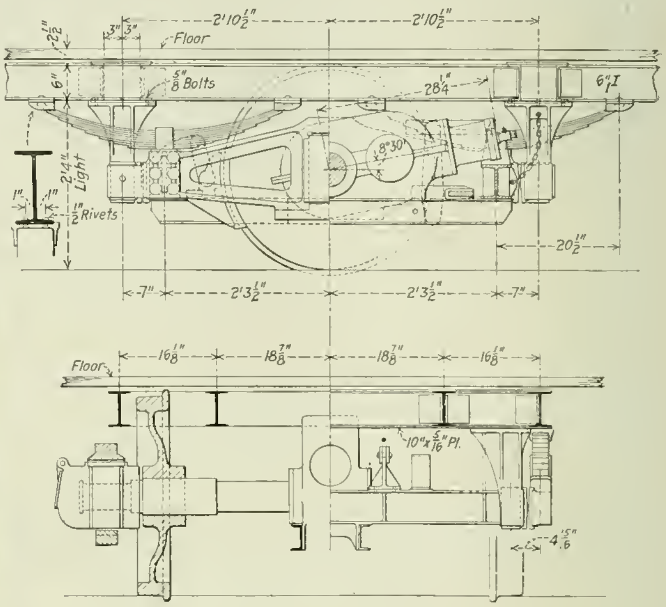
The two-wheel driving truck under the rear end of the car is of unique construction, combining the requirements of a fixed angular relationship between the center line of the axle and the center line of the car with a complete unity of construction which permits the rear axle with the brake rigging and gear case to be removed from the car intact. This truck is built up of cast steel side frames which are joined at the ends with cast steel cross pieces of I-section. The side frames are provided with pedestals for standard M. C. B. journal boxes. The gear case which surrounds the center of the axle is rigidly supported by two longitudinal members of rolled channel section, bolted to the underside of the truck frame end pieces. Lugs on the truck frame provide for the support of two brake beams, one in front and one at the rear of the driving wheels, which are fitted with M. C. B. standard brake heads and brake shoes. These are connected with simple clasp brake rigging, operated by Westinghouse semi-automatic air brake equipment.

Interior View of Passenger Compartment

The alinement of the truck with respect to the car body is maintained by four column castings bolted to the underside of the car underframe. These castings are provided with vertical wearing shoes on their inside transverse faces and outside longitudinal faces which bear against corresponding wearing shoes secured to the end pieces of the truck frame and to projections from the side frames. Lateral alinement is thus maintained at four points on the truck frame and the driving thrust in either direction is transmitted to the car body at two points through these shoes, which are free to move vertically with respect to each other.

The weight of the car body is transmitted to this truck frame through four semi-elliptic springs the center bands of which rest in suitable pockets in the truck frame and the ends of which bear against small flanged wearing shoes riveted to the underside of the car body underframe. The longitudinal distance between the front and back truck spring pockets is 4 ft. 7½ in., which is great enough to provide considerable transverse torsional stability to the gear case without sacrificing the complete freedom of the truck from attachment to the car body.

The engine is located under a hood at the front end of the car with the radiator let into the end wall just under the front window. The hood is asbestos lined in order to permit the space over the engine to be filled with small baggage or express packages, thus conserving baggage room floor space.



Details of Rear Axle and Truck

With a 10-ft. 4⅜-in. baggage compartment and 36-in. door openings at the sides of the passenger compartment, the car has a seating capacity of 36 persons. Other arrangements can be used seating as many as 43 passengers. The power plant is considered large enough to handle a trailer on grades not exceeding three per cent and a design has been developed for such a car 27 ft. 4 in. long over the channel undersills, which may be provided either with reversible seats or longitudinal drop seats. In the former case a seating capacity of 32 may be provided while in the latter case the seating capacity is 24. With the exception of the interior finish, the entire construction is of steel, the underframe or chassis, the longitudinal members of which are 6

DETAILS OF OPERATION OF THE BOWEN MOTOR CAR

Month	March	April	May
Days operated	31	30	31
Total miles	3,987	3,960	4,092
Passengers carried	4,240	3,721	2,780
Gross revenue	$1,215.82	$1,146.44	$844.40
Gallons of gas	677	599	620
Cost of Gas	$169.25	$144.76	$168.00
Cost of oil, grease and coal	11.16	18.53	15.00
Operating labor	260.00	207.80	183.68
Maintenance labor and parts	16.35	7.30	13.20
Total expense	$461.71	$378.39	$379.88
Net cash earnings	$754.11	$768.05	$464.52
SUMMARY			
Gross earnings per mile	.305	.289	.206
Cost of operation per mile	.115	.095	.092
Net earnings per mile	.190	.194	.114

The population on the line of above road is 175 per mile.

ft. I-beams, being completely standardized. Changes in the body construction and arrangement may be made to suit local requirements. The car illustrated weighs 28,000 lb. complete.

The first car built by the Bowen Motor Railways Corporation was placed in service about three years ago. It has now operated over 175,000 miles and is still in service. Its performance was carefully analyzed and while no fundamental defects developed, it was considered advisable to change the later design by making changes in the size and design of the car body.

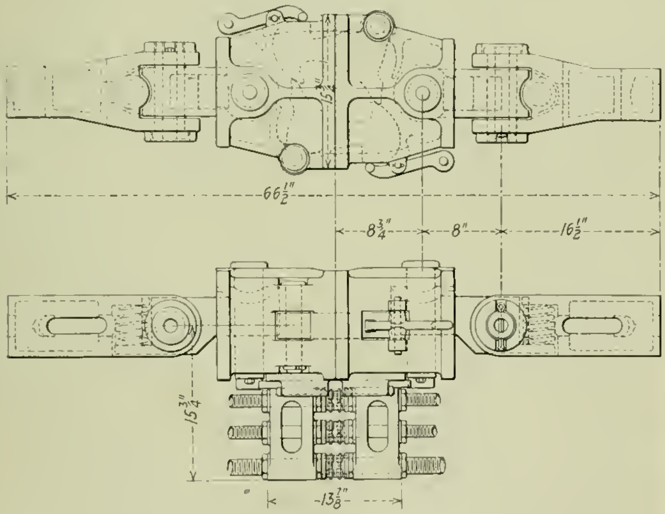
Records of the operation of these cars indicate that they can be run at a cost of about 18 cents per train mile where the railroad train service wage scale is in effect, or 12 cents per mile under non-union conditions. Further details of the cost of operation of a Bowen motor car on the Westfield Railroad are given in a tabulation herewith.

While this car is designed particularly for handling passengers, express, mail and baggage on short and branch line steam railways, it was also adapted for use on suburban electric lines where the cost of power is excessive. In new construction, the gasoline motor cars have important advantages over electric cars, eliminating the necessity for overhead wiring and the extra cost for the installation and maintenance of power stations.

A Combined Car Coupler and Hose Connector

Operating Principle and Construction of Coupler Differ Radically from Present Standard

A COMBINED car coupler and automatic steam and air hose connector in the design of which a complete departure has been made from the operating principle of the present standard vertical plane coupler, has recently been placed in service on a number of steam railway passenger cars. The device, which has been developed by the Universal Car and Hose Coupler Company, St. Louis, Mo., provides for no vertical adjustment between the coupler heads and the hose connector blocks are directly connected to the car coupler head.

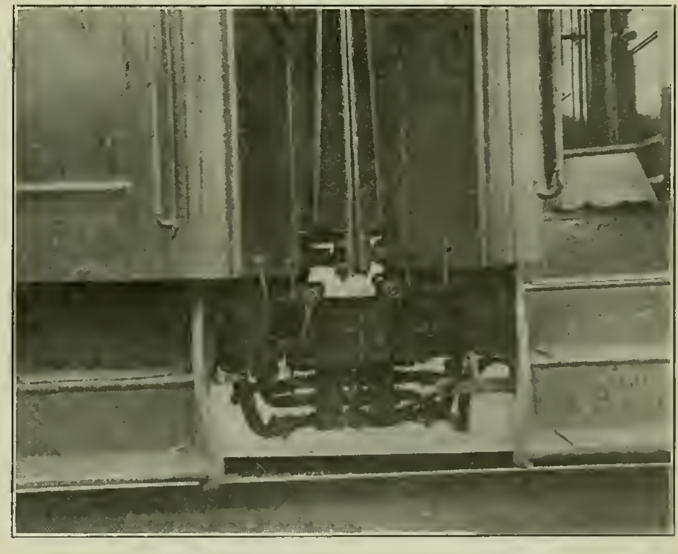


General Arrangement of the Universal Car and Hose Coupler

The operating principle of the coupler is clearly shown in the illustrations. From the drawing, which shows two of the devices coupled together, it will be seen that vertical and lateral adjustments are provided for by an intermediate section of the draw bar, hinged to the main draw bar by a larger horizontal pin. To the end of this the coupler head in turn is attached by a vertical pin connection. When uncoupled the coupler head is supported approximately in a horizontal position by means of a vertical coil spring acting on an extension from the lower side of the intermediate draw bar.

The coupler head presents a rectangular bearing face measuring approximately 11 in. vertically by 16 in. wide over all, the width of the bearing surface being about 1¾ in. From the left half of the rectangle enclosed by this bearing projects a tongue which is tapered both horizontally and vertically to provide for automatically bringing the coupler heads into alinement as they approach each other. Within the right half of this rectangular is a pocket to receive the tongue of the opposing coupler. The inside vertical face of this tongue is recessed to form a standard M. C. B. knuckle contour for use in interchange with standard equipment. A horizontal opening through the tongue is also provided for the so-called locking lug or latch which is attached to the coupler head by a 1⅝-in. knuckle pin. A cylindrical pocket 8 in. long by 1⅛ in. in diameter is drilled into the locking lug and in this recess is placed a 1-in. coil spring 5½ ins. long acting on a 1-in. pin projecting beyond the back side of the lug. This pin acting against an interior surface of the coupler head automatically maintains the lug in its locking position in which the locking or latch portion of the lug projects outward through the side wall of the adjoining coupler head when the two heads are locked.

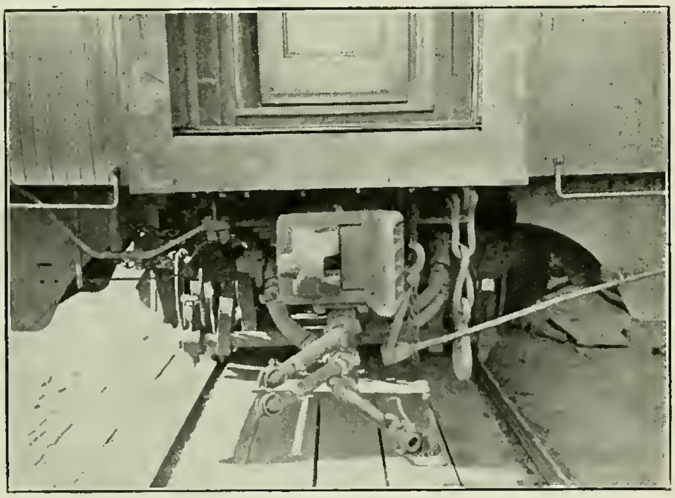
In coupling, as the bearing faces of the adjoining couplers are gathered into alinement, each automatically opens the latch of the adjoining head against the spring compression until the bearing faces come in contact. Each latch then closes into an opening through the side wall of the adjoining coupler head, thus locking the two heads together. In uncoupling, lateral pressure is brought against the face of one of the latches where it projects through the wall of the adjoining coupler head, by means of a suitable lever ar-



Universal Couplers in Passenger Service

rangement, thus pushing it back to clear the locking face of the coupler head with which it is engaged. The interior surface of the latch end of the locking lug engages a tail projection on the adjoining lug in such a manner that the one operation moves both lugs to the release position.

Owing to the fact that the adjoining coupler heads are permitted no freedom of movement relative to each other when coupled the opposed connector blocks are attached directly to the coupler heads, which, thus perform the function of alinement for the hose connections. All that is required, therefore, in the hose connector feature are end gasket connections located on the vertical center line of the coupler at fixed distances below its horizontal center line. These connections project beyond the face of the coupler, in which position they are maintained by coil springs housed within a connector bracket which is attached to the lower face of the coupler head. When coupled, the compression on these springs maintains a tight joint between the adjoining gaskets. To the rear end of the connector pipes are secured short hose connections lacing from the various train line pipes. The gasket ends of the connector pipes are arranged to receive adapter couplings, by which adapter hose can be readily attached for use in interchange with standard equipment.


Universal Coupler with Guard Arm Applied for Interchange with the Standard Car and Hose Couplers.

To provide for interchange with standard vertical plane couplers a casting, corresponding in contour with the guard arm of the standard coupler, has been designed to fit into the receiving pocket of the Universal coupler, to which it is secured by a lug on its lower face. This lug fits in a corresponding opening through the bottom of the coupler head. One of the illustrations shows this casting in place.

The principle purposes in the design of this coupler are to eliminate the necessity for going between cars to line up coupler heads or to couple air and steam; to interlock the two coupler heads in such a way that the draft stresses will be uniformly distributed over the head; to eliminate slack between the coupler heads and to keep them in correct alinement on curves as well as on straight track.

A Chemist in a Freight Car

BY H. J. FORCE

Of the enormous total bill for loss and damage of freight on the railroads of the country—over 100 millions of dollars yearly—an appreciable percentage is due to large losses on merchandise which is damaged by coming in contact with chemicals and acids. Many carloads of sugar, flour, coffee and other similar commodities have been seriously damaged by being loaded into cars in which the floors were contaminated by various kinds of acids. In some cases not only were the lower layers of bags eaten or damaged, but also those on the side of the car were eaten and the contents of the bags spilled over the floor.

Strong alkalies of which the drums have been broken open or leaked have produced similar results.

Machinery with parts nickel plated or galvanized have been badly corroded by the fumes of muriatic acid which had penetrated the floors. Rugs, carpets, cotton goods in rolls, etc., have been in many cases eaten 1 or 2 inches, thereby practically ruining the entire roll.

Cars which are contaminated with acid can be very easily detected. An acid car will in practically every case have the appearance of being oil-soaked or wet. Cars which are thoroughly dry or dusty have been found to be free of acid in nearly all cases. Blue litmus paper when placed in contact with acid will at once turn red; place a few drops of water upon the floor and lay the blue paper on the damp or wet place. In case the paper should not assume a reddish appearance red litmus paper should then be placed upon the floor. If the car is soaked with alkali the red paper will turn blue. Cars of this kind should be placarded "BAD ORDER," "ACID CAR" or "ALKALI CAR" and should in no case be used for loading any commodities which could be injuried or damaged by acid.

If there is no reaction to either the blue or the red paper the car is probably contaminated with oil, and should not be used for sugar, coffee, flour, dry goods, etc.

Cars which are badly contaminated by acid need a new floor or a new lining. Where only slightly damaged the acid can be removed by washing well with a hose and sprinkling with baking soda.

On the Lackawanna, careful inspection for acids and alkalies has eliminated damage claims of this class.

Vegetables, such as potatoes, cabbage, onions, etc., have been found to be badly damaged on the lower layers when loaded in cars contaminated with salt. Great care should be exercised in the selection of cars for food stuffs and no cars should be loaded with these products which are contaminated with acids, alkalies or salt.

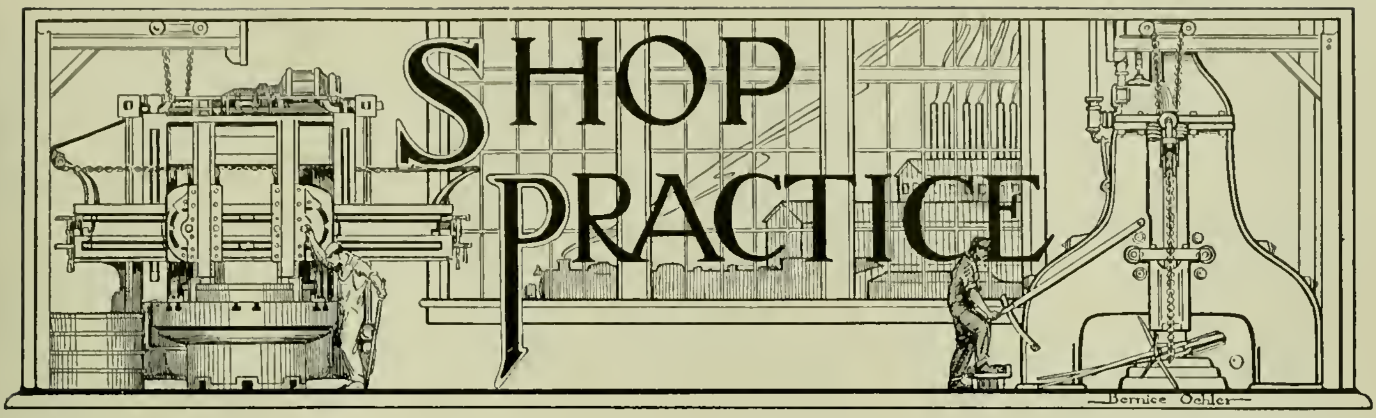
Covering the floor of the car with paper or sawdust will have little effect when the car is badly contaminated with acids or alkalies.

Passengers Riding Free on the Central Pennsylvania Division of the Pennsylvania Railroad are liable, if they don't "watch out," to receive from the conductor, when the train is filled, a small card bearing the following inscription: "Pay Passengers Are Standing. It, therefore, seems appropriate to remind the holders of passes of their duty to refrain from occupying seats."

* * * *


Photo by Underwood & Underwood

German Airdrome at Johannesthal Converted to a Car Shop.



Labor Board Lifts Piece Work Ban

The present labor crisis has been complicated by a decision of the Labor Board handed down on October 13 and containing drafts of 17 rules considered by the Board as just and reasonable rules for inclusion in all agreements between individual roads and their shop employees. One of these rules removes the present ban on piece work, and of the total of 17 rules, 10 have been so worded as to eliminate inefficient and uneconomical results caused by the application of the counterparts of these rules in the Shop Crafts' National Agreement. Seven rules of the National Agreements, Rules 8, 31, 61, 66, 67, 68 and 78, dealing respectively with Sunday work, seniority in departments, requirements for machinists, definition of "dead work," assignment of "dead work" forces to running repair work, machinists and helpers on wreck trains, and requirements for boilermakers, have been judged as just and reasonable by the Board and are made effective on October 16.

Can the Foreman Manage Himself?

The foreman must deal tactfully yet firmly with the workers under him. To control others he must first know how to control himself.

How many good employees are lost to the service because the foreman could not control himself at a critical moment? Not only does he do an injustice to the worker but he loses the respect of the other men, often with an unhealthy reaction on production.

Is it not true that the success of a department depends to a large extent upon the personality of the foreman?

The new rules promulgated by the Board are as follows, the rule number corresponding with the similar rule in the National Agreements and the italic portion indicating the changes made by the Board:

Rule No. 1

Eight hours shall constitute a day's work. All employees coming under the provisions of this agreement, except as *otherwise* provided *in this schedule of rules, or as may hereafter be legally established between the carrier and the employees,* shall be paid on the hourly basis.

This rule is intended to remove the inhibition against piece work contained in rule 1 of the shop crafts' national agreement and to permit the question to be taken up for negotiation on any individual railroad in the manner prescribed by the Transportation Act.

Rule No. 2

(Rule adopted as substitute for Rules 2, 3, 4, 5, of the national agreement.)

There may be one, two, or three shifts employed. *The starting time of any shift shall be arranged by mutual understanding between the local officers and the employees' committee based on actual service requirements.*

The time and length of the lunch period shall be subject to mutual agreement.

Rule No. 18

When new jobs are created or vacancies occur in the respective crafts, the oldest employees in point of service shall, if sufficient ability is shown by trial, be given preference in filling such new jobs or any vacancies that may be desirable to them. All vacancies or new jobs created will be bulletined. Bulletins must be posted five (5) days before vacancies are filled permanently. Employees desiring to avail themselves of this rule will make application to the official in charge and a copy of the application will be given to the local chairman.

An employee exercising his seniority rights under this rule will do so without expense to the carrier; he will lose his right to the job he left; and if after a fair trial he fails to qualify for the new position, he will have to take whatever position may be open in his craft.

Rule No. 46

Applicants for employment *may* be required to *take physical examination at the expense of the carrier to determine the fitness of the applicant to reasonably perform the service required in his craft or class. They will also be required to make a statement showing address of relatives, necessary four years' experience, and name and local address of last employer.*

Rule No. 48

Employees injured while at work will not be required to make accident reports before they are given medical attention, but will make them as soon as practicable thereafter. Proper medical attention will be given at the earliest possible moment, and *when able,* employees shall be permitted to return to work without signing a release pending final settlement of the case.

At the option of the injured party, personal injury settlements may be handled *by the duly authorized representatives of the employee with the duly authorized representatives of the carrier.* Where death or permanent disability results from injury, the lawful heirs of the deceased may have the case handled as herein provided.

Rule No. 50

Existing conditions in regard to shop trains will be continued unless changed by mutual agreement, *or unless, after disagreement between the carrier and employees, the dispute is properly brought before the Labor Board and the Board finds the continuance of existing conditions unjust and unreasonable, and orders same discontinued or modified.*

The company will endeavor to keep shop trains on schedule time, properly heated and lighted, and in a safe, clean, and sanitary condition. This not to apply to temporary service provided in case of emergency.

Rule No. 55

Work of scrapping engines, boilers, tanks, and cars or other *machinery will be done by crews under the direction of a mechanic.*

Rule No. 60

At the close of each week one minute for each hour actually worked during the week will be allowed employees for checking in and out and making out service cards on their own time.

Rule No. 65

Machinists assigned to running repairs shall not be required to work on dead work at points where dead-work forces are maintained *except when there is not sufficient running repairs to keep them busy.*

Rule No. 77

At points where there are ordinarily 15 *or more engines tested and inspected each month,* and machinists are required to swear to federal reports covering such inspection, a machinist will be assigned to handle this work *in connection with other machinist's work* and will be allowed five cents per hour above the machinist's minimum rate at the point employed.

At points or on shifts where no inspector is assigned and machinists are required to inspect engines and swear to federal reports, they will be paid five cents per hour above the machinist's minimum rate at the point employed for the days on which such inspections are made.

Autogenous welders shall receive five cents per hour above the minimum rate paid mechanics at the point employed.

In each case the italic portion of the new rule is intended to eliminate the objectionable features of the old rule, especially those to which the railroads objected during the hearings on National Agreements.

Three Locomotive Shop Devices

BY E. A. MILLER

Too many precautions cannot be taken to guard against accidents to the eyes of workmen employed in railroad shops and roundhouses. When grinding work on an emery wheel or when truing up such a wheel with a dresser, the rules are very strict regarding the wearing of goggles to prevent flying particles of dust and emery from flying into the eyes of workmen or operators. The use of goggles will ordinarily be a sufficient safeguard but, as an additional precaution, the curved steel plate, 3½ in. wide, as shown in Fig. 1, is fastened by means of two 3/16 in. machine screws to the emery wheel dresser. This plate is instrumental in deflecting most of the particles which fly from the emery wheel away from the man who is truing it up.

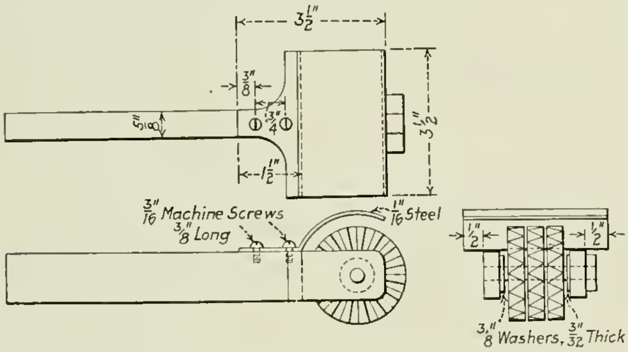


Fig. 1—Guard for Emery Wheel Dresser

Drilling Grease Plug Holes

After the bushings have been pressed in side rods, it is necessary to drill holes for the grease plugs which serve two purposes, controlling the supply of grease to the bearings and preventing loose bushings from turning in the rods. The common method of drilling these holes is to place the rod under some type of drill press and drill down through the brass bushing with a drill somewhat smaller than the smallest diameter of the grease plug threads.

There are two objections to this method in that the drill damages the threads in the rods and usually drills a hole which is off center in the rod bushing. When the attempt is made to apply a grease plug, it is often found, therefore, that the threads are damaged to such an extent that the plug cannot be turned into the rod. Moreover, the cylindrical end of the grease plug will not enter the hole in the brass bushing on account of the latter's being off center and the usual procedure for the machinist or mechanic is to grind down the end of the grease plug until it will fit the hole in the bushing. This results in the diameter of the plug being considerably smaller than would otherwise be necessary and should the bushing become loose in service, quite a little play of the bushing in the rod may be expected.

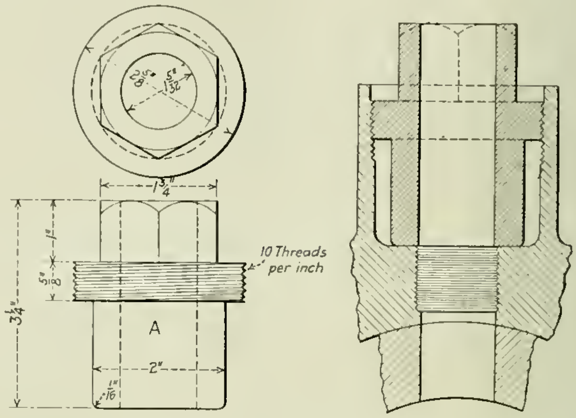


Fig. 2—Jig Used in Drilling Rod Bushing Grease Plug Holes

To obviate these objectionable features, the arrangement shown in Fig. 2 has been devised. It consists of a steel jig *A*, drilled for a 1 5/32-in. hole and formed at one end in an hexagonal nut. A collar is threaded, as shown, to suit the internal threads in the side rod grease cup. In using this jig, it is turned into the grease cup until it strikes the bottom and guides the drill when drilling the hole in the side rod bushing. It is apparent that this jig will not only guide the drill and prevent damaging the grease plug thread, but the hole in the rod bushing will be centrally located and no difficulty will be experienced in applying the grease plug.

Cab Apron Holder

The hinged sheet-iron apron between a locomotive and tender is quite heavy and often difficult to handle in coupling or uncoupling the tender, requiring the services of a man to hold it up unless some other method is provided. Fig. 3 shows a simple device for holding the cab apron in a horizontal position while making the coupling, thus avoiding the need of holding the apron by hand with consequent danger of accident. During the time that the locomotive is in the shop, the device can also be used to hold the apron up out of the way of workmen.

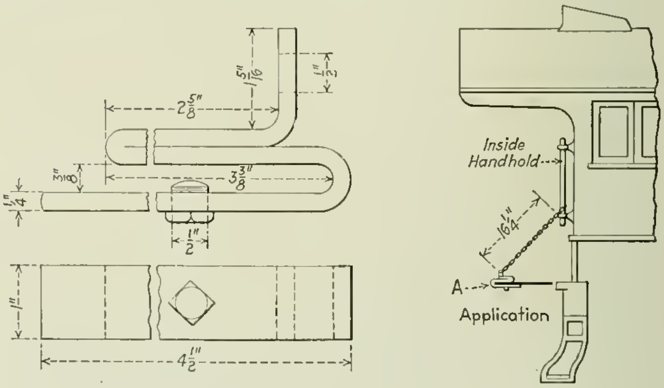


Fig. 3—View Showing Details and Application of Cab Apron Holder

The construction of the holder with set screw and supporting chain is readily apparent from the illustration.

Interesting Examples of Blacksmith Shop Work

Dies and Formers Used to Facilitate Work Under Heavy Steam Hammers; a Good Example of Gas Welding

BY WESLEY J. WIGGIN

Assistant Blacksmith Foreman, Boston & Maine, Billerica Shop, Mass.

THERE is opportunity for considerable saving both of time and money in blacksmith shop work, particularly by the use of carefully designed dies and formers in connection with steam hammers. In fact, by the use of suitable formers, it is possible to perform certain operations under the hammers in a small fraction of the time which would be required were such formers not available.

For example, Fig. 1 shows the details of formers used for offsetting end sills for standard motor trucks. The appearance of the straight sill and the former before offsetting is clearly shown in Fig. 2 and the finished sill in Fig. 3. The operation of the formers also is perhaps most clearly shown in these two illustrations from which it is evident that the base of the former rests on the anvil of a 2,000-lb. steam hammer with two forming blocks held at the proper distance apart by means of a 1½ in. round bar, bent at right angles at the ends for insertion in corresponding holes in the respective forming blocks. The blow of the hammer is delivered to a top die block, provided with a handle, shown in detail in Fig. 1. This handle fits in the two holes shown in

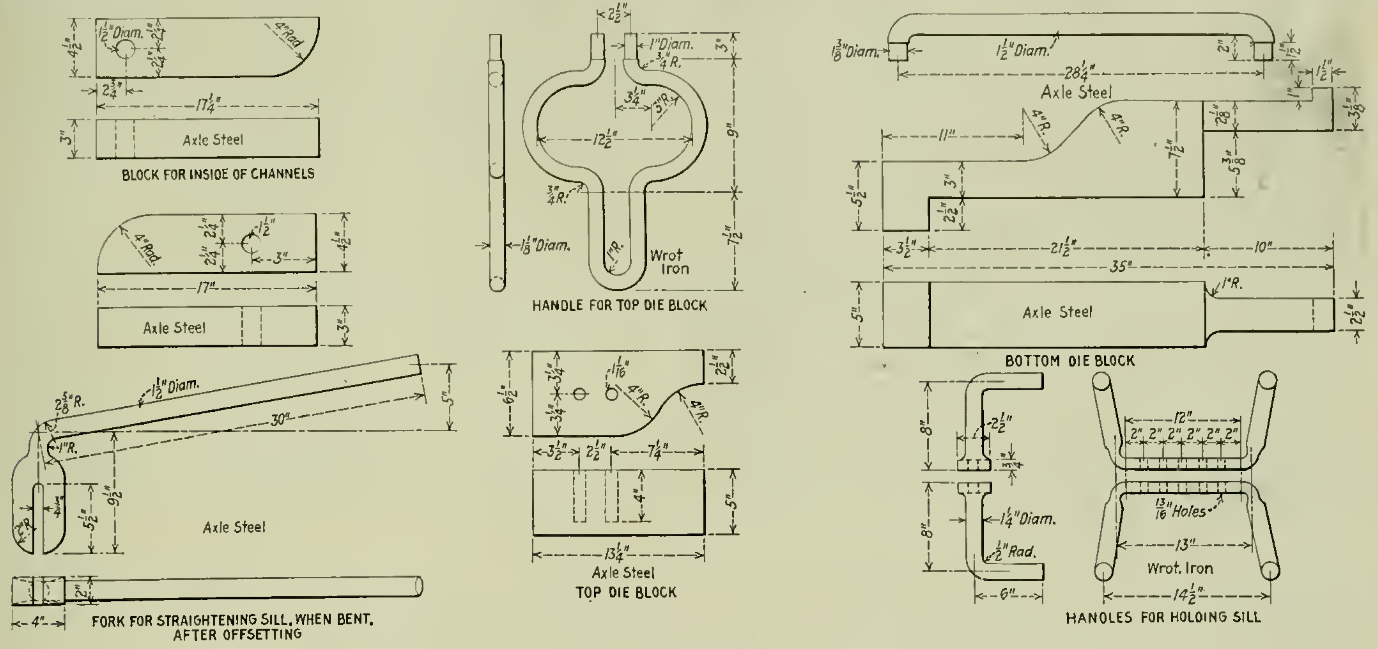


Fig. 1.—Details of Formers Used for Bending End Sill for Standard Motor Truck

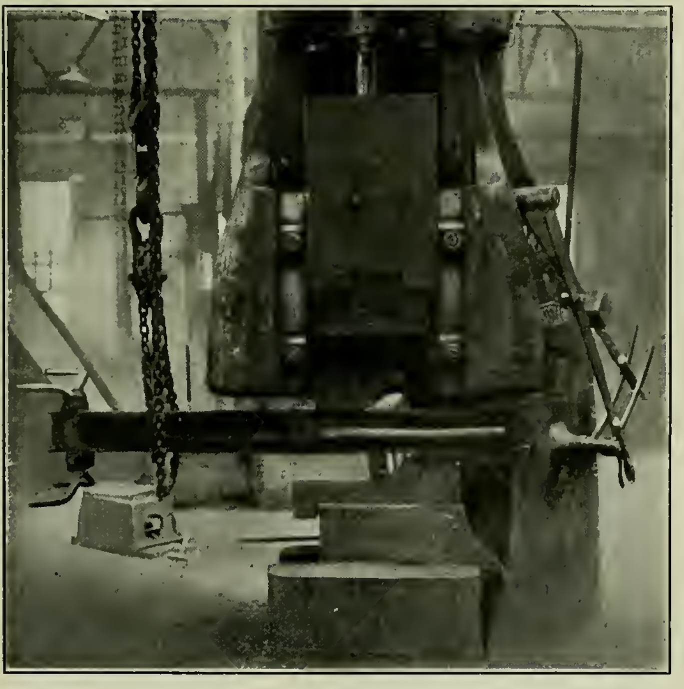


Fig. 2.—View Showing Formers in Place and End Sill Before Being Offset

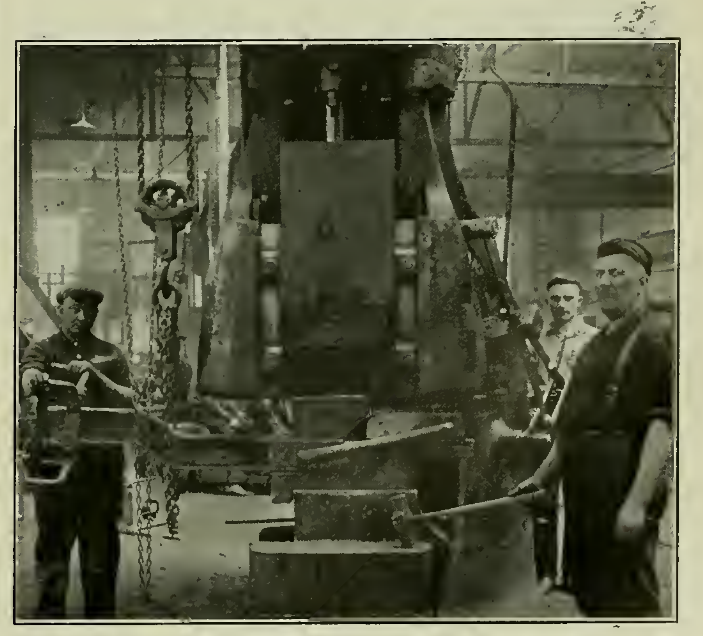


Fig. 3.—Formers and Sill After Being Offset

the top die block, the spring of the handle and friction being sufficient to hold the handle in place. A handle fork is provided for straightening the sill should it become bent after offsetting, although the dies perform the operation so accurately that this handle fork is not generally needed. Iron handles to facilitate holding and turning the sill are shown at the left in the illustrations, details being given in Fig. 1.

Reclaiming Bent I-Beams

When steel underframe cars become involved in wrecks it frequently happens that they are sent to the shop with the channels and I-beams going into the construction of the steel underframe badly bent. While these parts sometimes are damaged to such an extent that they cannot be reclaimed, most of them can be straightened and used again provided hammersmiths, experienced and skillful in work of this character are available.

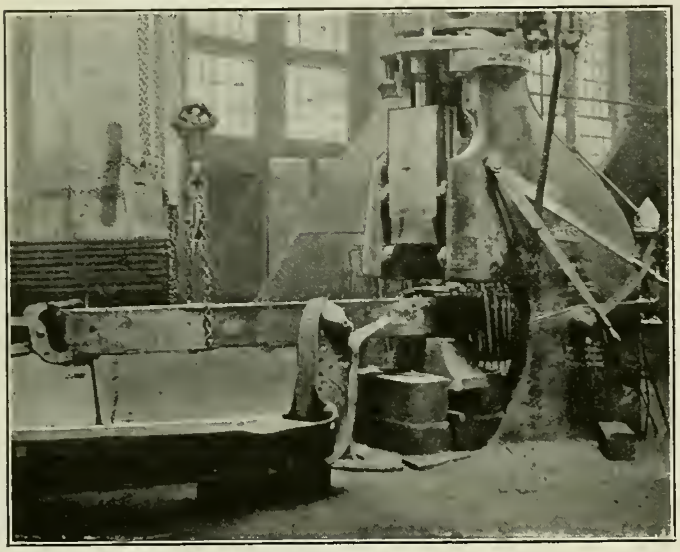


Fig. 4.—Straightening a 10-In. I-Beam

Two 10-in. I-beams, one of which has been subjected to unusually severe usage, are shown in Fig. 4 in the process of straightening. One is under the hammer practically completed and the other is on the floor. In straightening these steel underframe members, it is essential to work them no more than necessary, otherwise they will be lengthened and holes will not line up when the member is reapplied to the steel frame. A little working will not make much difference, but where the beam is heated and bent too many times, it will be found necessary to relocate and drill bracket and other holes.

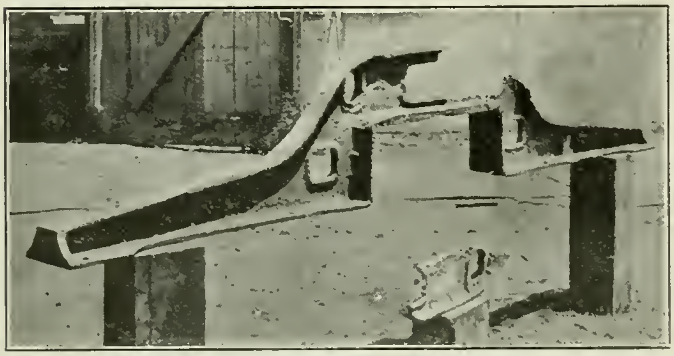


Fig. 5.—Broken Needle Beam of Commonwealth Steel Underframe

Welding a Needle Beam

The repair of the broken needle beam of a Commonwealth steel underframe is illustrated in Figs. 5 and 6. It will be observed from Fig. 5 that a section of the needle beam was broken out due to the wreck of the coach containing this steel underframe. The broken part was successfully rewelded in place as shown, the repaired needle beam then being as good as new.

It is important in work of this kind where the repaired parts are subject to vibration and severe stress that experienced welders only be used. While the judicious use of the welding torch will save many thousands of dollars, it is equally true that much discredit has been brought to the use of autogenous welding processes due to inexperienced operators who fail to appreciate the limitations of the torch and use it indiscriminately and without the employment of good judgment. In all welding not only should the welds be carefully made, but internal stress in the parts due to contraction after cooling should be relieved. This can be accomplished easily in most cases by slowly heating the opposite members with the torch and allowing them to contract equally, or in some cases, however, it may be necessary to heat the entire part to a dull red heat and allow it to cool slowly to atmospheric temperature.

Fig. 6.—Needle Beam, Shown in Fig. 5, As Repaired by Gas Welding

Repairing Tube-Sheet Cracks in Locomotive Boilers*

The firebox tube-sheets of locomotive boilers sometimes develop cracks between the tubes, and the question of repairing these cracks is a matter of interest. Frequently the work of repairing tube-sheets falls to the engine terminal staff, as at the time the cracks develop, the locomotive may not have run the necessary miles to warrant a shopping for general repairs. Often it is found possible, when a locomotive is sent into the shops, to repair a cracked tube-plate rather than renew it.

The method of repair depends upon whether or not the boiler is empty of tubes. If only a few tubes in the vicinity of the cracks are removed a good repair can be made by threading the tube holes which have their bridges cracked and inserting tapered brass plugs. Heads are formed on the plugs which meet one another and entirely cover the cracks. The centers of the plugs are then drilled to receive the tubes, the tubes in this case being smaller than the original to allow of a substantial thickness of metal in the bushing. This method makes a fairly good repair as the tubes have an unbroken contact surface and the cracks are covered and protected by the heads of the plugs.

Another method often employed is to insert plugs as in the previous case, and then bore a tube hole into every alternate plug, leaving the remainder solid and plugging up the corresponding holes in the smokebox tube-plate. The tube-plate is thereby strengthened in the parts which are cracked, but the heating surface is reduced and additional stress thrown on stays which may be in the vicinity.

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* Abstract of an article in the August 12, 1921, issue of Engineering, describing a method of repairing cracks in copper tube sheets, but which should be equally applicable with steel tube sheets.

Gas Machine Cutting in Railroad Shops

A Discussion and Illustration of the Uses of the Radiagraph —a Mechanically-Operated Torch for Cutting Sheet Metal

CUTTING with oxy-acetylene hand torches in locomotive and car shops has become so general and presents so many advantages that railway shop men will naturally be interested in some of the applications of mechanically-operated cutting torches, of which the Radiagraph is an example. Machines of this type have already been installed in certain railroad shops and afforded in some cases remarkable opportunities for time and labor saving. While all of the illustrations given in this article are not taken directly from railroad shop practice, the operation in each case is similar to many which have to be performed daily in locomotive and car repair shops.

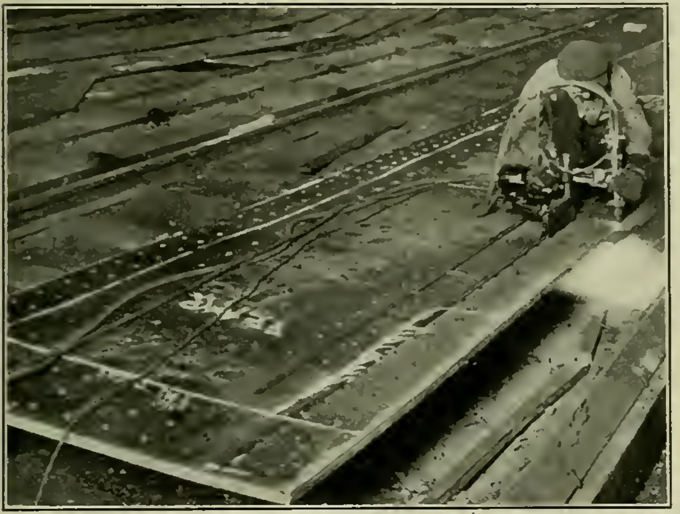


Fig. 1—Trimming a Steel Plate with the Radiagraph

Straight Line Cutting

Referring to Fig. 1 it will be evident that the Radiagraph is being used for straight line cutting in trimming the steel plate illustrated. There is a large amount of this work to be done in railroad shops not only in the boiler department but especially in shops equipped to handle steel car repairs. It will be noted that the Radiagraph, which is a machine weighing about 50 lb., operates on a light, weight grooved track, made in sections five feet long. When cutting straight lines two sections of the grooved track are required for long cuts, one section being taken up after the machine has passed over it and placed ahead of the section then in use. This process is repeated indefinitely depending on the length of the cut.

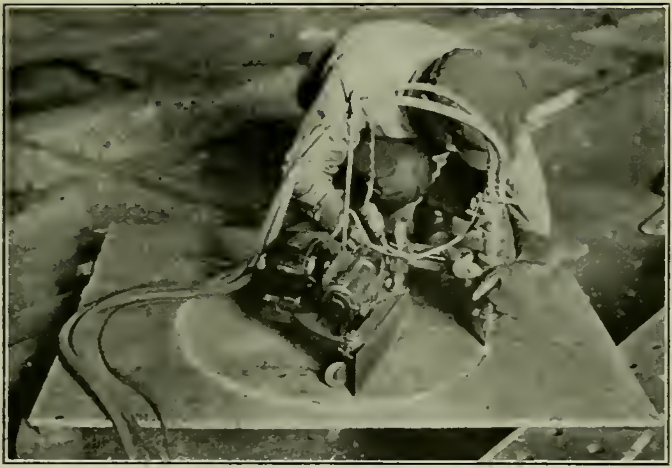


Fig. 2—Cutting to a Circle in ½-In. Steel Plate

The cutting torch is held in a double swivel at the end of a radial arm adjustable vertically and laterally. A triangular frame work carrying the torch and driving gear is supported by three wheels, one at each corner, thus making a carriage. Two of the wheels are used for traction on straight line cutting, being driven through gearing by a 1/20-hp. electric motor. A gear-box interposed provides for 20 speed changes, the speed used depending upon the thickness of the metal to be cut and the required smoothness of the cut. Ample power for the electric motor is provided from any light socket and the motor is set in motion by the act of opening the valve controlling the oxygen cutting jet, a switch being mounted on the end of this valve. The machine is started when the metal has been heated to the cutting temperature and the oxygen jet is turned on.

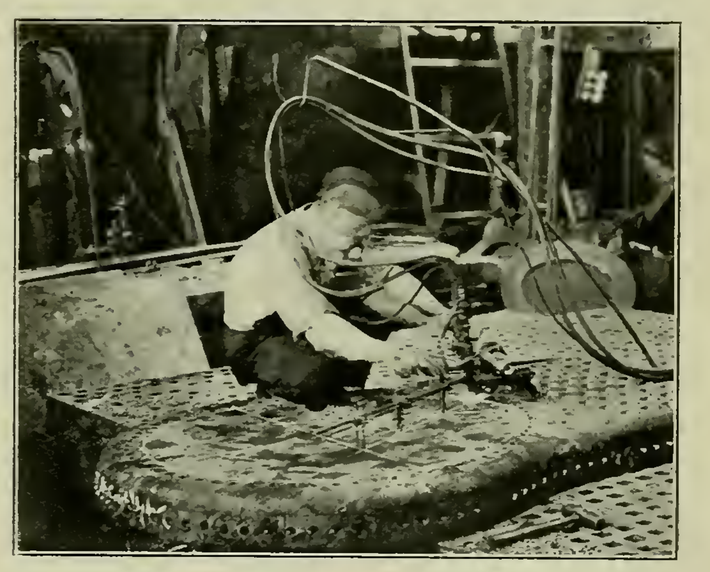


Fig. 3—In Cutting an Oval Opening, the Machine Swings on Three Different Radial Lengths Successively

A peculiar advantage of the above arrangement is that the torch can be adjusted sideways to any desired angle in the swivel holder, thus producing a beveled edge. Trimming and beveling are therefore done at one and the same time.

Cutting to a Circle or Oval

The illustration given in Fig. 2 shows the use of the Radiagraph in cutting a circle in a ½-in. steel plate. There are many occasions in railroad shop work when it would be an advantage to have means for quickly and accurately cutting circles in steel plates. The Radiagraph is adapted for this purpose by disengaging one of the two tractor wheels, the drive then being affected by one tractor wheel only and the entire machine swivelling about an adjustable center point resting in a prick punch mark at the center of the circle. It is important to note that the speed of the cutting torch can be reduced to a point giving the required smoothness of cut so that additional machining will be unnecessary. This elimination of additional machining is a valuable feature of the Radiagraph and one which enables it to affect large savings in production cost.

The circular cutting, illustrated in Fig. 2 may be varied to produce elliptical or oval shaped, or cutting a combination of arcs and straight lines. When cutting the oval opening in a combustion chamber head, Fig. 3, the operator manipulated the adjustable center points successively, thus changing the effective length of the radius bar, without stopping the cut. In this case the machine swung on three different radial lengths successively. While it is not probable that much elliptical cutting will be found in railroad shops, the flexibility of the Radiagraph is plainly shown by its ability to handle this operation and should the occasion arise to cut an elliptical hole in sheet iron the use of the machine will reduce the cost.

Particular attention is called, in Fig. 3, to the method of suspending the two lengths of acetylene and oxygen hose and the electric extension cord from a support over the center of the table. This enables the Radiagraph to work without interference from the hose and cord.

Locomotive Frame Cutting

The use of the Radiagraph in cutting openings in small electric locomotive side frames for the axle boxes is plainly shown in Fig. 4. While work of this exact nature will not be encountered in railroad shops, the illustration is given on account of its general interest and to indicate the possibility of the Radiagraph in cutting thick metal. In this particular case the locomotive frames are made from steel slabs, 3½ in. thick, by cutting out the axle box openings. On short cuts like this, one section of track only is used. An ordinary cutting speed for low carbon steel, 3½ in. thick, is from 8 to 12 in. per min. but in this case the cutting was required to be done with such precision and smoothness that no machining afterwards would be needed and the feed rate, therefore, was reduced to three or four inches per minute. The resultant cuts are smooth, being comparable to a slotter cut made with fine feed and a pointed tool.

The practice in cutting the frames illustrated is to lay out and drill all holes including starting holes at the corners of the openings and all cuts are made tangent to the drilled holes so that a true radius is left in the corners. The material removed by cutting is salvaged, being used in the forge shop and elsewhere for parts that can be worked up from the material available.

In ordinary locomotive repair shop practice, the Radiagraph can be successfully used in working up ashpan sheets and doors, boiler mud rings, flue sheets, crown sheets, back heads, door frames, running boards, steps, reinforcing rings, cab doors, connecting rods, eccentric rods, equalizers, levers, links, pipe flanges, etc. In car shop work, side sheets, end sheets, hopper bottoms, hopper doors, brake levers and hangers constitute a few of the steel car components that may be advantageously machine cut with oxygen. A feature of the portable oxygen-cutting machine, very important in car shops and yards, is the saving of transportation to machine tools which must necessarily be located at points convenient to the whole area served. If, however, a lightweight gas-cutting machine is taken to the work, time and labor are saved and often mistakes avoided due to misunderstanding of layouts.

Inclining the Torch When Cutting

Straightaway cutting with the hand torch is facilitated by inclining the head of the torch backward after the cut is well started. The degree of inclination will vary somewhat with the thickness of the metal and other conditions. A fairly conservative figure is 65 to 75 deg. angle from the plate behind the torch to the torch head. The effect of inclining the torch is to speed up cutting considerably. The gases directed at an angle preheat the thin edge of undercut metal ahead of the igniting temperature more rapidly than when the tip is held squarely with the plate. The gases and products of combustion turn backward, passing through an arc of, say, approximately 90 deg. and shooting down and back. Often the drag or lag of the cut will be as much as one-half or even three-quarters inch on half-inch steel. When cutting with the torch inclined, it should be uprighted just before finishing the cut in order to sever the metal at the end. Otherwise a wedge of uncut metal will be left due to the oxygen shooting by the corner as the torch reaches the end of the cut. The "drag" part of the cut will be left untouched. Uprighting of the torch cuts this portion off cleanly.

Expert hand cutters are able to cut one-half-inch steel plate with a very narrow kerf and low oxygen pressure, often working at speeds up to 24 in. per min. and sometimes faster. The experienced cutter learns to follow the cut with great precision, going no faster than permissible, but still following the combustion rate so closely that there is little or no loss of cutting efficiency. The cutter who tries to work too fast "loses the cut" and makes a mess of things. The cutter who works too slow wastes gas and time, while the one who knows just how fast to cut approximates 100 per cent efficiency in time and gas.—*Autogenous Welding.*

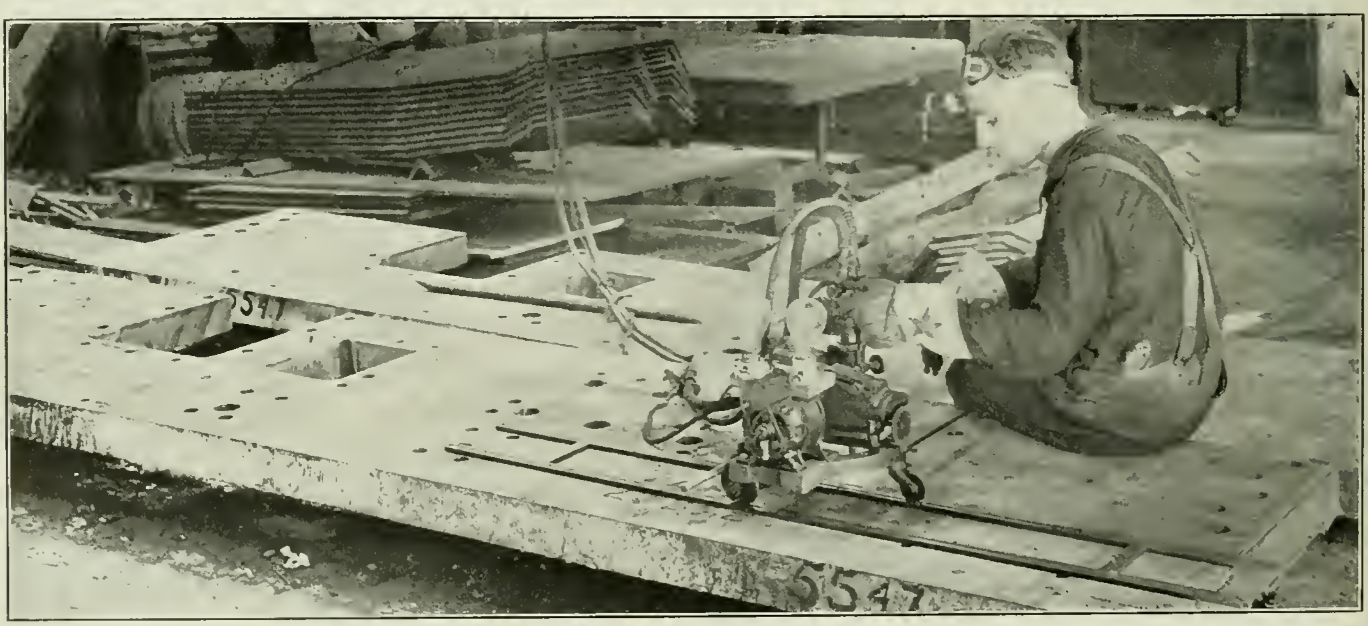


Fig. 4—Cutting 3½-In. Steel Slabs for Small Electric Locomotive

Construction and Maintenance of Cinder Pits

Report of American Railway Bridge and Building Association Committee Discusses Three Types

CINDER pits may be divided into the following types: (A) Depressed track pits where ashes are loaded into cars by hand. (B) Dry pits where ashes are received in cast iron buckets and loaded into cars by means of an overhead crane. (C) Water pits, both shallow and deep, where ashes are removed by clamshells operated by a locomotive or overhead crane and loaded into cars. (D) Miscellaneous pits, where ashes are removed by various mechanical means.

Fig. 1 shows a standard pit used by the Duluth, Missabe & Northern at Proctor, Minn., which is typical of the handloading pits installed by many of the railroads in this country. The pit is constructed with one rail resting on the back wall of concrete, and the other on two 10-in. channels back to back with cover plate top and bottom, the channels being supported by cast iron pedestals on 7-ft. centers. This pit has failed in one respect: The action of the hot cinders and water on the top and face of the back wall have caused it to crumble and produce an unsafe bearing for the rail. No trouble has been experienced with the cast iron pedestals, and with a reasonable amount of cleaning of the hot cinders away from the steel beams, they do not buckle. The beams require cleaning and painting every spring and fall. The back wall can be protected with old plates ¼-in. thick hung over the edge of the back wall on the inside of the pit and down the pit about 3 ft., leaving an air space between the cinders and the concrete. This will prolong the life of the back wall.

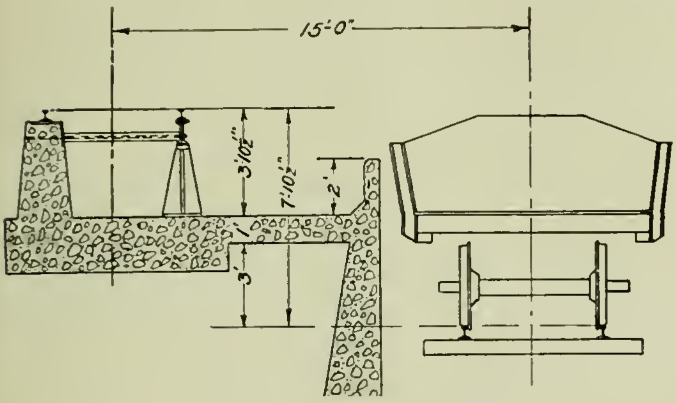


Fig. 1—Standard Cinder Pit of the D. M. & N.

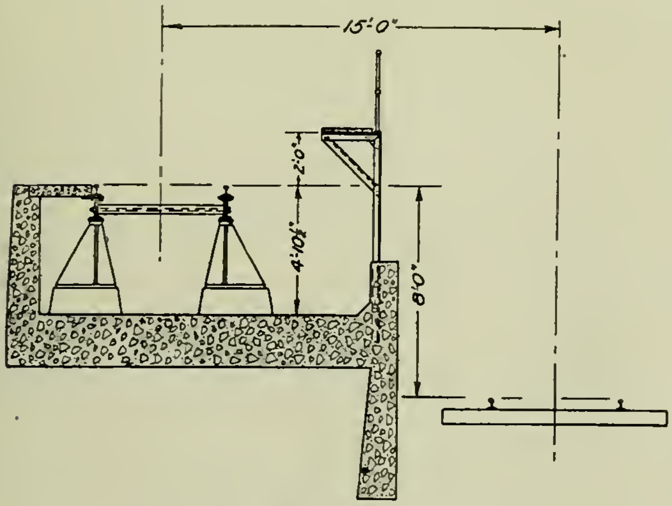


Fig. 2—A Second Design of Type A Pit

Fig. 2 shows the pit deepened and both rails supported on cast iron pedestals with a pre-cast slab between the rail and back wall; this design keeps the rail off the concrete wall and leaves the beams and pedestals exposed where they can be replaced in a few minutes if a failure should occur.

Fig. 3 shows a dry pit used by the Bangor & Aroostook, and is similar in construction to Fig. 1, the difference being that the bottom of the pit slopes from the back wall to the center of the pit; the beam carrying the track is made of two 70-lb. rails placed upside down to support the track; the pedestals are spaced 6 ft. ⅜ in. between centers and are built of two 70-lb. rails back to back on end and encased in concrete, the concrete being protected by a ⅛-in. steel plate; these vertical rails are supported by two 70-lb. rails running lengthwise in the foundation.

The Buffalo, Rochester & Pittsburgh has built a pit of Type B at Lincoln Park, N. Y., shown in Fig. 4, which seems to be a favorite design for a dry pit in cold climates. This pit can be built with one track and a loading track, or if the length of the pit is fixed, several tracks can be built side by side. This style of pit is constructed of a series of cast steel buckets placed in shallow pits to receive ashes direct from locomotives. There is enough depth provided under the buckets to allow for drainage. The buckets are handled by means of an overhead crane from the pit directly to the ash cars. The pits are of an unusual shape with sloping sides in the upper part and a narrow rectangular lower portion, old rails being imbedded in the sloping surfaces with their bases projecting ⅛ in. from the surface of the concrete; each parapet wall is capped with a 12-in. channel to which the track rail is bolted. The buckets have a capacity of 2 cu. yd. each, each seated on the projecting rails of the pit walls. When the buckets are filled the traveling crane carries them to the cinder cars where they are dumped automatically. The buckets open at the bottom like a clam shell, the two halves being carried by a pair of scissor levers at the middle.

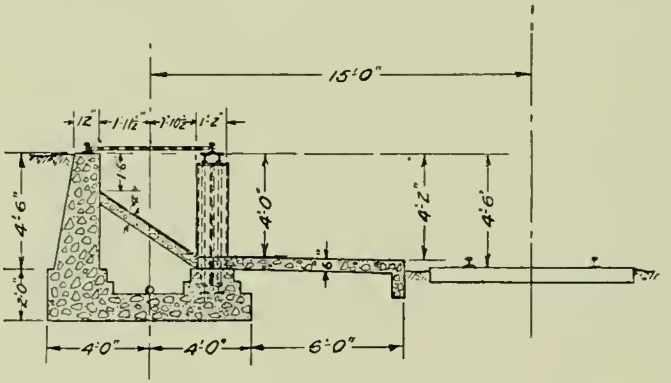


Fig. 3—A Dry Pit Built by the Bangor & Aroostook

The Lehigh Valley has two modern water ash pits of Type C, both being built within the last three years. The one at Coxton, Pa., Fig. 5, is a double-track arrangement, 400 ft. long with a water pit between the two tracks. The water pit is 12 ft. wide in the clear by 14 ft. 3 in. deep, the ash tracks having 29-ft. centers. The water in the pit is generally within 1 in. of the bottom of the carrying rails, so that it is impossible to overheat or burn any part of the supporting structure. The outside rail of each ashing track is carried on the outside concrete wall of the pit, bearing on a ½-in. iron plate. The inside rail of the ashing track is carried by three rail girders supported by heavy cast iron posts with large bases imbedded in the concrete. These carrying girders consist of two 136-lb. rails, side by side, with spacing blocks so designed that the base of the track rail, also of 136-lb. section, rest on and are gripped between these spacing blocks and the heads of the two lower carrying rails, forming, when tightly bolted together, a rigid girder.

The walks around the ashing tracks of this pit consist, on the outside, of the natural surface of a cinder fill, while on the inside the walk consists of 80-lb. rail brackets fastened to the cast iron columns. The rail brackets carry the floor of the walk, consisting of old boiler flues laid side by side and spaced by means of iron straps, so that the finer ashes fall through. A suitable railing, also of old flues, amply protects anyone from falling into the water pit.

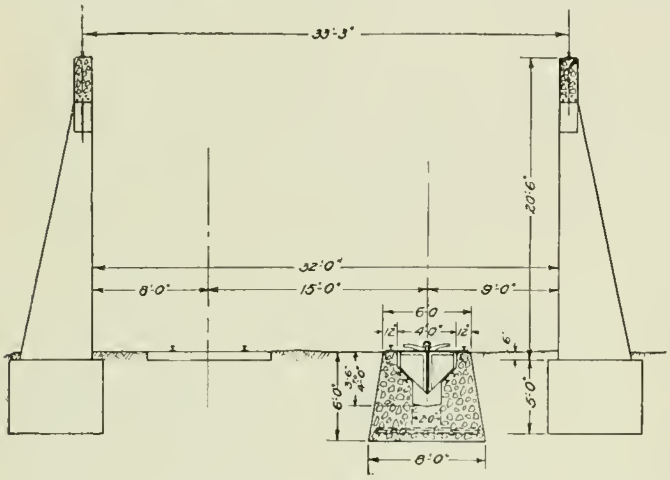


Fig. 4—Type B, Pit Built by the Buffalo, Rochester & Pittsburgh at Lincoln Park, N. Y.

Crushed slag was used in the concrete for the pit as a precaution against hot cinders coming in contact with the concrete while the pit is without water.

The Pere Marquette installed a mechanically-operated pit in January, 1912, which seems to be a favorite for small terminals and shows a low cost of operation. From recent reports the pit and conveyor are in good shape with very little maintenance. There are two good points in favor of the mechanically-operated pit. It requires less room, due to cinders being loaded continually into cars; and it requires but one man to operate it, which makes for a low operating cost. The structural steel in these pits should be inspected, cleaned and painted frequently.

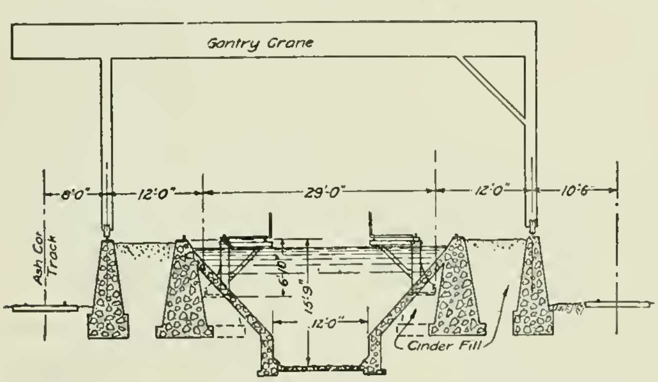


Fig. 5.—Type C, Water Pit Built by the Lehigh Valley at Coxton, Pa.

The report was signed by G. K. Nuss (D. M. & N.), chairman; C. L. Beeler (N. Y., N. H. & H.), Wm. Cardwell (Wash. Term.), H. A. Gerst (G. N.), W. L. Rohbock (W. & L. E.), F. E. Schall (L. V.), E. R. Wenner (L. V.), J. P. Wood (P. M.), A. E. Kemp (L. V.).

Discussion

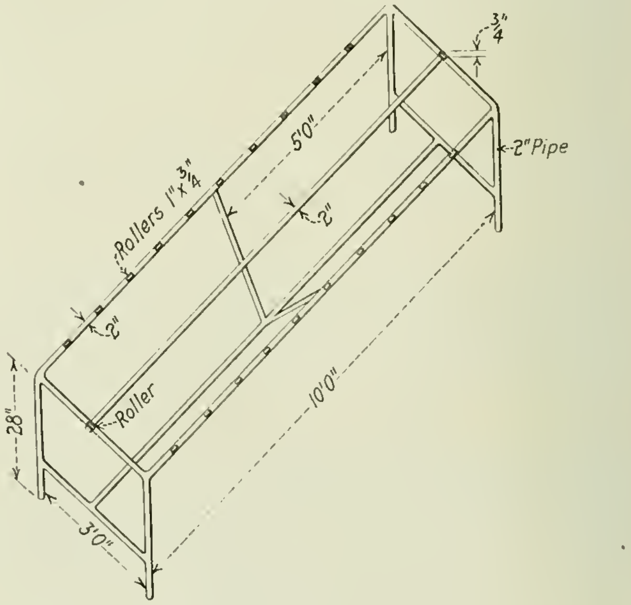
The discussion hinged largely on the efficient use of the ash pits in connection with the equipment and the disposal of the cinders. It was emphasized by Arthur Ridgeway (D. & R. G. W.) that no car had as yet been developed that would handle hot cinders without resulting in the destruction of the car body by burning or warping. Quenching was necessary though it gave considerable trouble in the winter with the handling of the cinders. It was stated by J. S. Robinson (C. & N. W.) that at the Chicago terminal the cinders are loaded into out-bound empty coal cars, moved to West Chicago, and there unloaded by locomotive cranes and stored. Later they are loaded as needed, and distributed to branch lines for ballast and to other places where they can be used to advantage. Other members stated that their roads make a practice of storing cinders in the winter to obviate the difficulty of handling them when frozen. L. D. Hadwin (C. M. & St. Paul) stated that one difficulty arose from the fact that the use of locomotive cranes to handle cinders has the disadvantage in that it may be taken away and used out on the line with the result that the cinders pile up in quantity, and in the winter time freeze.

Table for Oxy-Acetylene Cutting

BY J. J. ALBERT

Repair Track Foreman, Michigan Central, Kensington, Ill.

An effective form of table for holding sheet metals while being cut with a torch is shown in the illustration, the idea being to have the plates brought to the operator on rollers with no undue exertion on his part and enabling him to stand in one place. The table is built of two-inch pipe, twenty-two—1-in. by ¾-in. rollers being used to carry the work to the operator. These rollers extend ½ in. above the surface of the table, being applied on pins cut and welded into the pipe. This arrangement leaves the rollers free to revolve and by having the table center brace ½ in. below the surface of the table the material will not drag if it sags down but will bear on the rollers only. The value of this table as described lies in the fact that it can be quickly and cheaply constructed, at the same time assisting materially in the work of oxy-acetylene operators when cutting all kinds of sheet metal.



Cutting Table Built Up of Rollers and Pipe Sections

The Metallurgy of High Speed Steel*

A Brief Outline of the Development, Characteristics and Method of Manufacturing High Speed Steel

BY D. M. GILTINAN

DEVELOPMENT of high speed steel as distinguished from carbon tool steel has been a matter of the last 50 years. The development of the present day cutting alloys in this short space of time, as compared with the hundreds of years previous in which there was no development, calls for some explanation. This explanation lies in the fact that the manufacturing industries of the civilized world have, during the same period, demanded a means for securing increased production without the increase in cost which would accompany additional buildings and equipment. The alternative was to speed up each individual machine, and in attempting to do so it at once became apparent that the tool steel then in use would not meet the requirements of increased speed. These requirements were:

1. The tool must possess initial hardness greater than the material cut, and also must be sufficiently hard to resist wear.

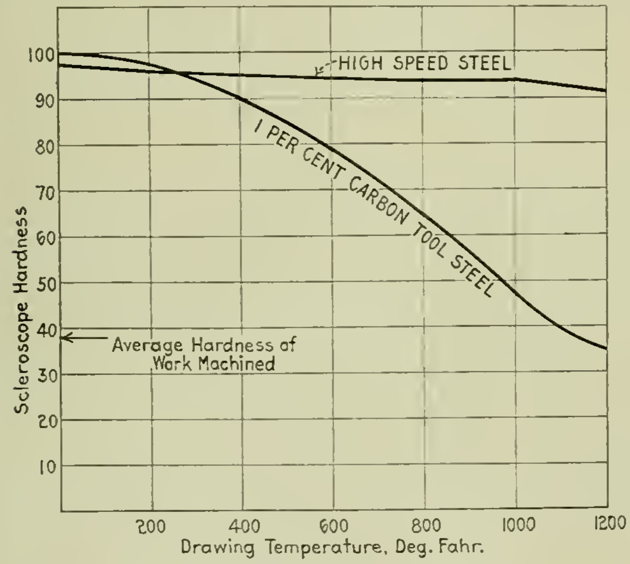


Fig. 1—Effect of Heat on Hardened Steel

2. The tool must not soften when subjected to the heat developed through friction, due to increased relative speed of the tool and the work.

Tool steel, in the generally accepted sense of the word, is an iron-carbon alloy containing from 0.6 to 2.0 per cent carbon with an average of approximately 1.0 per cent carbon. The carbon exists as iron carbide, or cementite, Fe_3C, which is extremely hard and above 1,350 deg. F. the stable condition of the alloy is a solid solution of Fe_3C in the iron or ferrite. Below 1,350 degrees F. the Fe_3C separates out of the solid solution and the stable condition is a mixture of Fe and Fe_3C, which is comparatively soft, due to the cementite being isolated in globules or plates in the soft ground mass of ferrite. If the solid solution is cooled rapidly the carbide is held in solution, resulting in uniform hardness throughout; but the alloy is in a meta-stable condition and will revert readily to the stable upon application of heat. This softening commences at about 300 deg. F. and at 1300 deg. F., or dull red, has become very soft as illustrated in Fig. 1.

Present high speed steels, on the other hand, when properly hardened are initially hard, and moreover there is only a small decrease in hardness when heated to a dull red; that is, high speed tools are as hard when operating at speeds where friction is sufficient to make the tools red hot as are carbon steels, when operating under conditions of very light cut and feed and low speed.

Development of Modern High Speed Steel

The development of modern high speed steel started about 1866, when Robert Mushet of Sheffield discovered the value of manganese as an alloying element of bessemer steel, giving added ease of fabrication. In the course of further experimental work with manganese on tool steels he noted that one particular composition possessed the property of hardening when cooled in air. This was distinctly out of accord with the knowledge of steel hardening at that time, and careful analysis developed the fact that there was considerable tungsten present in addition to the manganese. The combination of tungsten and manganese in conjunction with high carbon resulted in lowering to below room temperature the point where the carbide separated out of the solid solution, giving the property of "air hardening," a term which was at once applied as a trade name to this particular steel.

F. W. Taylor in 1900 discovered the great increase in cutting speed made possible by heating tools practically to melting point when hardening. This was a revolutionary step, as it had always been known that heating a carbon steel any higher than necessary to produce uniform solution of the carbide resulted in a coarsening of the crystallization and accompanying brittleness when hardening. In fact, a carbon tool steel heated as high as 2300 deg. F. would be absolutely ruined. Further work at Bethlehem showed the advantage of higher chromium content, and between 1902 and 1906 there was in Europe and America a movement which resulted in the adoption of carbon content now generally in use (0.60 to 0.80 per cent) and increasing the amounts of chromium and tungsten up to the maximum of 7 per cent chorium and 24 per cent tungsten. It was found, however, that the maximum efficiency was obtained with a chromium content of 3 to 4 per cent and 18 per cent tungsten. Molybdenum was also tried in place of tungsten, or to replace it partially, but it was found that while molybdenum produced an excellent high speed steel, it was rather uncertain and caused seams and hardening cracks so that its use was discontinued.

About the same time vanadium was added in this country, and, while it was found that it improved the cutting capacity, it was thought, erroneously as it later turned out, that the increase obtained did not compensate for the additional cost entailed. In 1908-1909, Europe and America brought out simultaneously a high tungsten steel containing approximately 1 per cent vanadium which met with immediate success, and since that time vanadium has been an essential component of practically all high speed steels. Its action has never been understood fully, and there have been few attempts to explain its effect, which is to increase the life of the tool when working at high temperatures.

Methods of Manufacture

The manufacture of high speed steel involves no different processes than those by which all high grade cutting steels

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*From a paper presented before the Charleston chapter of the American Society for Steel Treating. The author, D. M. Giltinan, is associated with the micro laboratory, Bureau of Research, United States Naval Ordnance Plant, Charleston, W. Va.

have made for the past hundred years, although, of course, like all other manufacturing processes, certain refinements and minor improvements are made from time to time. At the present time in this country, most high speed steel is made by the crucible process, although the electric furnace method is gaining in favor, due to the ability of the latter to refine low grade material. In the crucible process a predetermined amount of high speed steel scrap, low carbon bar iron, ferrochrome, ferrovanadium and either tungsten powder or ferrotungsten are packed in crucibles and sealed with sand or clay. Each pot holds about 100 lb., and about 30 to 35 pots are put in the furnace at one time, melted and thoroughly mixed after melting by pouring into the ladle, from which the ingots are cast. As soon as the metal in the ingots is solidified the mold is stripped and ingots are cooled very slowly, either in ashes or in a soaking pit. Extreme precautions must be taken, as high speed is very sensitive to rapid temperature changes and would crack if allowed to cool suddenly.

The ingots are then annealed to remove any strains set up in casting, and are carefully heated for fabrication. The ingots may be either rolled or hammered to bars after which the latter are reannealed and are ready for shipment. It is customary to ship bars annealed in order that any machine work may be done on them.

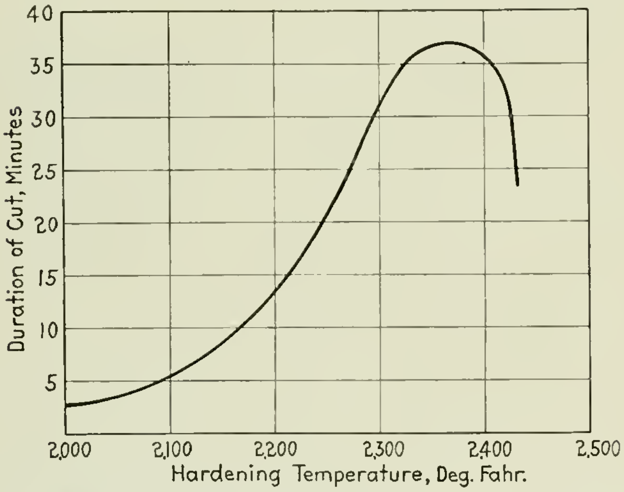

Fig. 2—Effect of Hardening Temperature on Cutting Capacity of High Speed Steel

Microscopic examination at high magnifications (500-1,000 diameters) shows that high speed steel in the annealed state consists of a matrix of what is probably the solid solution of iron and tungsten, which is studded with innumerable globules or "ponds," identified as carbides or tungstides of iron and chromium or a combination of both.

Upon quenching this steel from ordinary temperatures, that is, 1,400-1,700 deg. F., there is practically no change in structure and there is only partial hardening, showing that solution of the carbide is necessary for hardness. Tools hardened from these temperatures do not realize the possibilities in any way. It is only by heating to at least 2,250 or 2,300 deg. F., that the carbide may be brought into solution and it is then only that the full possibilities as a cutter tool are obtained. The effect of hardening temperature on cutting capacity is shown in Fig. 2. There is, of course, an extreme in high temperature, and if this is passed, more injury than good results. The steel is partially melted and an intergranular eutectic, which is extremely brittle, is formed upon cooling. This eutectic structure cannot be broken up by annealing and is always a source of trouble.

Red hardness is due to the conversion upon heating of the austenitic structure to martensite, which theoretically increases the hardness and which many investigators have found to be the case. Personally, the author has not found an increase, but has found that the hardness remained practically constant. In view of the extreme sluggishness with which the carbide goes into solution upon heating, it is natural to suppose that it will separate out of solution just as sluggishly upon reheating, thus accounting for the long time a high speed tool will run at red heat before failure.

Important Part Played by High Speed Steel

The practical importance of high speed steel is shown by comparing the manufacturing establishments of today with similar plants 20 years ago. The development of the present rate of production has been the result of a contest between the steel manufacturer and the machine tool manufacturer, with the producer as an interested spectator. The supremacy has alternated between the two contestants: first, one having a tool steel capable of higher speed than the machine would stand, and the other retaliating by building a machine of ample strength and free from vibration which would withstand a speed capable of burning up the tool. At the present time, the manufacturers of machine tools lead, and the next advance must be made by the steel manufacturer. Personally, the author believes that a cutting alloy whose hardness is not dependent on carbon and which is unaffected by heat is the coming high speed tool. The realm of alloys has yet only been touched since the number of alloying elements available and the possible combinations will give an infinite number of resulting compositions out of which can be found, one alloy or range of alloys which will have the toughness and keenness of steel and the heat-resisting qualities, or red hardness, of the present day nonferrous alloys.

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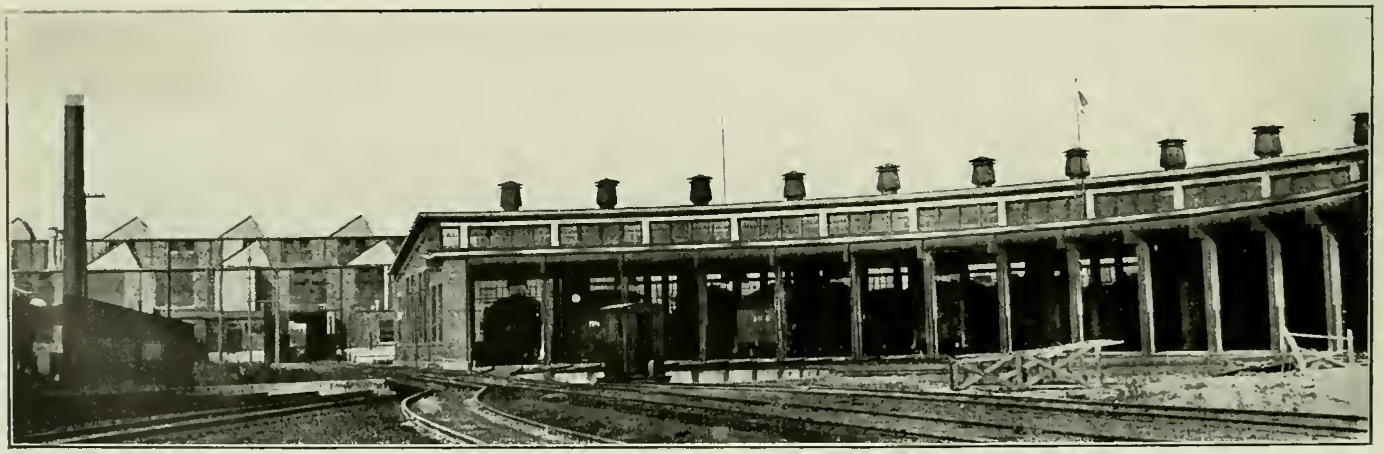


Boiler Makers' Committee Reports Released

Reports on the Welding of Safe Ends and the Cause of Boiler Shell Cracking Through Rivet Holes Are Given

OWING to conditions over which it had no control, the Master Boiler Makers' Association cancelled the convention scheduled to be held in St. Louis, May 23-26, 1921, and the Executive Committee authorized the publication of reports of committees on subjects prepared and filed for that occasion, with the idea that members would thus be able to study the reports and be prepared to discuss them more fully at the convention. It was also hoped that members would offer suggestions enabling the respective chairmen to revise or amplify their reports for the 1922 convention provided it seemed advisable. The following two committee reports are presented in full by permission of the Master Boiler Makers' Association.

Methods of Welding Safe Ends on Locomotive Boiler Tubes

In submitting a report on the above subject, and as chairman of this committee, in making a composite report, I have therein embodied the substance of individual reports by the other committeemen, as well as information gathered by the chairman during the year in visiting large railroad shops throughout the country and in past personal experiences.

Standard Safe End Practice

We will first take up the welding of safe ends in the regular way which is in vogue in most of the large railroad shops; *viz.:* the oil furnace, roller and hammer welders. It seems to be the consensus of opinion of the committee that no difficulty is experienced in welding iron to iron, steel to steel, iron to steel, or vice versa. In this connection I wish to say, however, that where steel is being welded to iron, it is good practice to give the iron somewhat of a lead in the heat, as steel will weld very readily up from 2500 deg. to 2600 deg. F., and iron fuses nicely at about 2800 deg. to 3000 deg. This can be very readily done when heating the tube and opening it to receive the safe end; then return to the furnace immediately and it will have about the required lead in heat over the steel. If the tube should be placed in the fire with both iron and steel cold, I believe it to be good practice to set the material in the furnace so as to give the iron the benefit of the heat. With this practice there should be no trouble in welding steel to iron, or vice versa.

The committee seems to be somewhat divided on the scarfing of safe ends. A large number of shops are welding safe ends to tubes without scarfing, with very good results. The committee, however, recommends that the sharp burr be taken off the outer edge of the safe end before inserting it into tube; otherwise when being rolled down in welding the sharp edge cuts in and thereby weakens the wall of the tube, causing the tube in some cases to break off. It is my opinion that the scarfed safe end makes the smoother weld, providing the scarf is properly made; about ½ inch in length and at the thinnest end to be not less than 1/16 inch thick, instead of scarfing them down, as we find in a good many cases, to a feather edge.

It is the further opinion of the committee that it is not necessary to use flux in welding, the reason being that in a good many cases dirt and foreign matter become mixed with the flux, and when it is applied to the metal prevents cohesion, and the result is a defective weld. If the flux can be kept perfectly clean there seems to be no objection to its use. A very fine sand is being used in some places, and it is claimed with very good results. If, however, the welding qualities of the material are right, and the furnace constructed so that it will properly heat the material, there should be no trouble in welding without the flux.

Causes for Poor Welds on Safe Ends

Investigating complaints of trouble experienced in the welding of safe ends, we find that this can be attributed mostly to one or two things, or both—improper construction of the furnace and the roller welding machine not being speeded up to the revolutions necessary to make a quick and sound weld. The roller welding machine should have a speed of not less than 450 revolutions at the fly wheel. The material being of a light wall, it cools very rapidly, and therefore must have quick action for fusing. In our opinion, some of the trouble complained of is due to the oil burners being set so that they play directly upon the material to be heated; especially is this a fact in short furnaces. Where the oil is of a good grade and light, there seems to be no trouble in properly heating the material, but when the oil is dirty and of a heavy grade, proper combustion will not take place in the short distance. The results are that where specks of this oil strike the metal along the line of the weld the material will not amalgamate; the result is a defective weld. The burner should be placed so that it will not blow directly upon the material; better at right angles, either top or bottom. In some cases I have found that they mixed heavy crude with kerosene oil; this brought about better combustion and better results were obtained from the furnace. The heavy oil clogging the burner causes the temperature to fluctuate, and the material is wasted in the furnace without being given the proper degree of heat for welding. The temperature of the furnace should be kept above the welding heat; if possible, 300 deg. to 400 deg. F., and it is the opinion of the committee that it is necessary to use a pyrometer only in cases where the desire is to establish the proper heat for welding. This, however, is not necessary with an experienced flue welder, as his eye will readily detect the proper degree of heat for welding, and the pyrometer should only be used as a matter of education.

Use of the Electric Welding Machine

Welding safe ends by the electrical welding machine, in the opinion of the committee, will eventually supersede the present method. John Doarnberger, a member of this committee, for the benefit of the Association, has made a number of tests, both as to cost, quality of material, and strength of welds. He states that the average consumption of power is about 20,000 watts; or in other words, 20 kw. In considering the cost, the current is one cent per kw. hour delivered to the machine, and would cost about 20 cents per hour for current. Mr. Doarnberger claims that he can turn out about 85 flues per hour, which would make the cost per flue about ¼ cent for current. To operate this machine, however, it is necessary to have available alternating current, 60 cycle, with 110 or 120 volts. The machines will not operate on direct current but will operate very satisfactorily, however, over a wide range of voltage. The present machine at the Roanoke, Va., shop, Mr. Doarnberger states, has a minimum of 170 and a maximum voltage of 300, and under these conditions it is commercially possible to put them on any lighting or power circuit that may be available, providing the current is generated in a standard apparatus, or purchased from any ordinary lighting company operating under conditions as found in the average town.

The Norfolk & Western now has in service approximately 280,960 tubes welded by this method, 152,000 being welded in 1919, and no failures are reported. The Union Pacific is welding about 60 tubes per hour. It claims to have over 700,000 in service, and only two service failures out of this number, those that failed being in service more than three years.

Chamfering Safe Ends

In connection with electric welding tubes I find tubes and safe ends being chamfered to about 30 degrees at the Omaha shop and when the safe end is inserted there is a lap of about 3/16 inch, and this, in my opinion, is the better method; or, I would prefer it over the butt-welded, because if the material carbonized and broke off at the weld, after going into service, it would drop into the boiler. On the other hand, if it is lapped there is less liability of the tube breaking off from the safe end completely, and in this way there would be less damage.

At the Atchison, Topeka & Santa Fe shops I found the most up-to-date electric welding machine, which has a roller attachment on the machine, the tube being heated and rolled down without moving from the machine to the roller, as is the practice in other shops where the spot welder has no roller attachment. These people, however, are using the machine mostly for reclaiming, welding from 6 inch to 10 inch and about 35 or 40 tubes per hour.

Following is the strength of new 2¼-inch tubes without a weld:

37,820 pounds	Average 37,921⅔ pounds.
37,770 pounds	
38,030 pounds	
38,030 pounds	
38,030 pounds	
37,800 pounds	

Coke Welded

31,130 pounds	Average 33,236⅔ pounds. Efficiency 87⅔ per cent.
36,380 pounds	
28,370 pounds	
37,060 pounds	
32,550 pounds	
33,930 pounds	

Electrically Buttwelded

31,290 pounds	Average 34,020 pounds. Efficiency 90.6 per cent.
37,240 pounds	
33,020 pounds	
38,770 pounds	
33,450 pounds	
30,350 pounds	

The chairman of the committee has also conducted a test with 12 electrically welded two-in. tubes which proved to have an efficiency of over 90 per cent.

In conclusion, I wish to say that in most large shops—with the present method of furnace, roller and hammer welding—two men are employed in the welding, one piecing up and the other welding. In this way the tube is not allowed to cool off and it takes less time to heat; you might say this brings about continuous welding. I find that in most up-to-date shops they claim to weld about 50 tubes per hour, some places, however, are doing even better than that.

The report was signed by P. J. Conrath, boiler tube expert, National Tube Company, Chicago, Ill., chairman; J. A. Dearnberger and Alfred R. Stiglmeier.

Cause of Boiler Shell Cracking Through Girth Seam Rivet Holes

Your committee respectfully submits the following for your consideration:

One member of the committee after 45 or 50 years' experience can recall only 10 boilers which failed when the boiler shell cracked circumferentially. Five were locomotive boilers which cracked through the rivet holes at the external lap, two cracked through the rivet holes at internal lap, and one through the main plate at the abutment of the lap. Two return tubular boilers cracked through the rivet holes of the external lap. These boilers all developed cracks ranging in length from three to four feet, extending about equal distances to each side of bottom center line.

The locomotive boilers had double riveted girth seams and the tubular boilers single riveted girth seams. The girth seams in all boilers which cracked did not become defective because of a low factor of safety as they had factors in excess of that prescribed by both the governments of the United States and Canada. Not one of these cracks resulted in the explosion of the boiler.

The other two members of the committee, after making inquiries and observations from numerous railroads, find very few boiler shells cracking through the girth seam/rivet holes and what has come to their attention was due to carelessness in preparing the sheets for riveting.

It must be quite clear to all of us that the plates in the steam space on the locomotive boiler must expand to a greater extent than the water space of the shell of the boiler, and the difference in the expansion between the top and bottom of shell in the locomotive type of boiler is dependent on the temperature of the steam at the top and the water below.

At first it would be thought that the top of the boiler would fail in advance of the bottom, but this is not so, because expansion is occurring equally and normally over every unit of its length, whereas the lower shell is subjected to a higher tension of stress brought about by the expansion of the top, which stress the bottom cannot equal because of its low temperature. This, in our opinion, causes the cracking of the shellplate through the girth seam rivet hole and the shell of the boiler, usually starting at the bottom.

It is our opinion that the rivet hole should be drilled in the girth seam and sheets properly prepared for riveting, and other improvements, which would quicken circulation such as applications of feed water with top checks located at the top of the boiler and at a distance from the fire; feed water heaters to raise the temperature of the feed water; automatic feed water regulation with regulators which would supply and keep the water as near as possible at a normal working level under all conditions. Also keep the expansion pads that secure the boiler to the frame free. Allowing the boiler to breathe and move freely in the frame will often prolong the rupture.

In our opinion with such improvements in general use on boilers the differential between the expansion of top and bottom of the shell would become more normal, with a reduction in the number of failures and the cracking of rivet holes in the girth seam, and the time of rupture be prolonged.

The report was signed by Andrew S. Greene, general foreman boiler maker, Big Four System, Indianapolis, Ind., chairman; William A. McKeown and T. W. Lowe.

Safety Code for Compressed Air Machinery

The American Society of Safety Engineers has been designated as sponsor for a safety code for compressed air machinery by the American Engineering Standards Committee. The code will include rules for the construction and use of compressors, tanks, pipe lines, and the utilization of apparatus where compressed air is the active agent. In accordance with the usual procedure, the code will be formulated by a sectional committee composed of representatives designated by the various bodies interested.

This work is being undertaken as part of a comprehensive program of safety codes in process of formulation under the auspices and rules of precedure of the American Engineering Standards Committee. The American Society of Safety Engineers was appointed sponsor for the code for compressed air machinery on the recommendation of the National Safety Code Committee.

Oxy-Acetylene Cutting Tests

BY JOHN C. EICHNER

A large part of the cost of any oxy-acetylene cutting or welding job is the cost of oxygen used and any method tending to reduce oxygen consumption without affecting torch efficiency is therefore of interest. The following test data were secured in tests recently conducted in a railroad boiler shop using a cut-weld torch made by the Alexander Milburn Company, Baltimore, Md. The tests were divided into two parts, one designated "Competitive" in which the manufacturer's expert demonstrators used the torches; and the second "Shop Conditions" in which one of the cutters from the boiler shop handled the torches. On the competitive tests the oxygen and acetylene gas pressures were set by the manufacturer while in the tests under shop conditions the pressures were those generally used in the shop for similar cutting.

The following schedule of tests was observed:

Competitive Conditions

300 ⅝ in. rivets cut from sides and end sills of steel hoppers.
100 ft. (approximately) cut from scrap locomotive firebox sheet.
3 holes 1¼ in. diameter cut through 5-in. locomotive frame.
3 smallest diameter holes cut through 5-in. locomotive frame.

Shop Conditions

100 ⅝ in. rivets cut from sides of steel hopper cars.
27 ft. (approximately) cut from new ⅜-in. steel plate.
83 sq. in. (approximately) cut from scrap steel tire 3 in. by 5½ in.
Back-fire tests.

In conducting these tests conditions were made constant for all torches as far as possible so as to get accurate comparisons both on the competitive and shop conditions. In the competitive tests a slight variation in conditions was caused by having to use a larger number of scrap firebox sheets than was at first thought necessary, because it was not possible to remove the sheets in large sizes. On the shop tests, conditions were identical in all cases.

DATA SECURED IN TESTS OF CUTTING AND WELDING TORCHES

		Based on hourly performance		Based on rivets, 25%; Firebox, 50% tire, steel, 25%	
		First test	Second test	First	Second
⅝ in. rivets	Number of rivets cut per hour..	294	326	294	326
	Cost per rivet....................	0.0081	0.0075	0.0081	0.0075
	Cost per hour....................	2.38	2.45	2.38	2.45
⅜ in. steel	Sq. in. ⅜-in. steel cut per hour...	450	527	450	527
	Cost per sq. in..................	0.00767	0.0059	0.0077	0.0059
	Cost per hour....................	3.45	3.11	3.45	3.11
3 in. tire steel	Sq. in. of 3 in. tire cut per hour..	1,027	991	1,027	991
	Cost per sq. in..................	0.0052	0.0053	0.0052	0.0053
	Cost per hour....................	5.34	5.24	5.34	5.24
Total	Sq. in. cut in 3 hours............	1,771	1,844	2,221	2,371
	Sp. in. cut in 3 hours...........	1,771	1,844	2,221	2,371
	Average cost per hour............	3.72	3.60	3.66	3.48
	Average sq. in. cut per hour......	590	614	555	593
	Relative values based on 1,000 sq. in. as unit of work—Cost per 1,000 sq. in..................	6.31	5.86	6.59	5.87
	Minutes to cut 1,000 sq. in........	102	98	108	101

The tests of cutting rivets and plate were made primarily to obtain comparisons in economy and speed. The tests of cutting holes in 5-in. locomotive frames were made in order to cause the torch and tip to undergo fairly severe heat conditions without destroying the torch for further use. The test results shown herewith are based on observed and calculated data derived from the shop test.

Overcoming an Objectionable Column Where Crane Service Was Desired

BY NORMAN McCLEOD

It frequently happens that in some shop buildings the use of valuable space is prohibited because of the interference of a building column, especially if it is desired to have crane service over the space involved. In a specific instance of this kind the column was composed of two 12-in. channels and one 11-in. I-beam as shown at *A*, Figs. 1 and 2. As it was necessary to have crane service for the work in this department, it was decided to design a full circle, five-ton motor hoist runway jib with trolley, the whole to revolve completely around the column.

The design, as finally approved for installation, is shown in elevation in Fig. 1, details being given in Fig. 2. The trolley jib is composed of two No. C2 40-lb. Carnegie channels, spaced 10 in. apart and bent one to the right and the other to the left, as shown at *B*, Fig. 2. The jib is bolted to a casting, *C*, made in two parts with a runway race for 1-in. diameter steel balls, the whole to encompass and made to revolve around the column on ball bearings, shown in detail at *E*, Fig. 2. The upper casting is supported by a lower pair of castings, *D*, bolted permanently to the column. Castings *D* have a corresponding race for the above mentioned steel balls.

It will be noticed that in both top and bottom pairs of column castings, provision is made for a groove 1⅛ in. by 2 in., in which are placed steel tempered rings (in halves) with the usual V runways for the accommodation of a total of 69 one-inch steel balls for the bearings.

On the outer end of the trolley jib is a casting which acts as a spacer for the two 10-in. channels as well as a portable support for them as shown at *F*, Fig. 2. Two wheels, 9½ in. in diameter, provided with roller bearings, are employed to support the weight of the jib on the runway and provide as nearly as possible frictionless radial movement of the jib.

The outer end of the jib and any load which may be

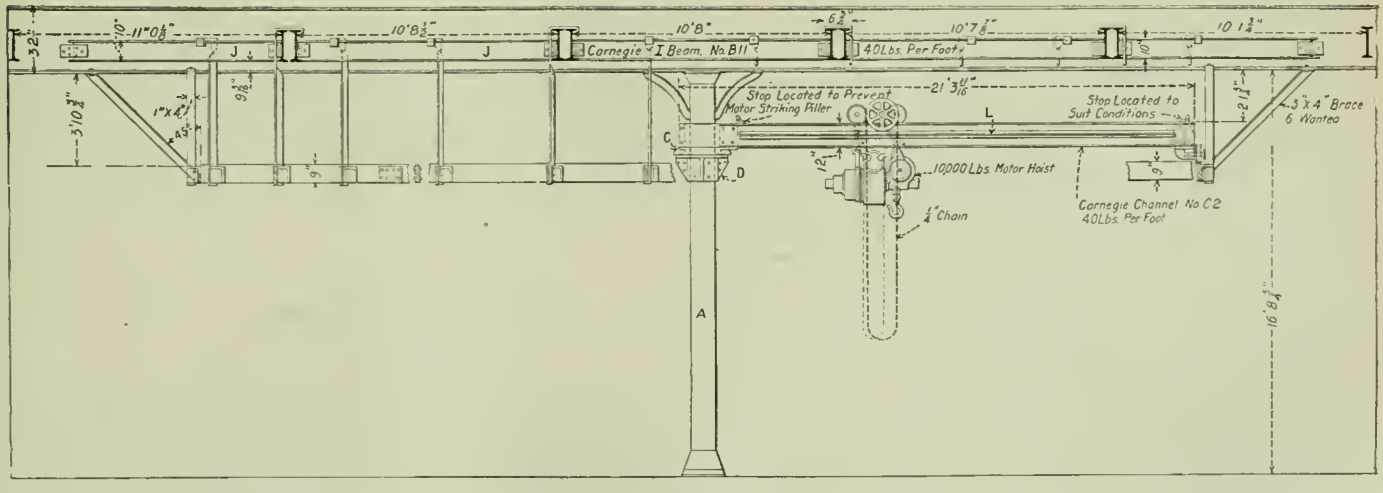


Fig. 1—Elevation Showing Column and Arrangement of Jib Crane with Motor Hoist

imposed upon it is supported by a circular 1½-in. by 9-in. wrought iron runway 41 ft. 0 in. in diameter. This runway is suspended from the ceiling above by 24 one-inch by four-inch wrought iron hangers (see details shown at *H*, Fig. 2), made to hook over the top of, and bolted to, the structural steel I-beams *J* which are framed into the steel beams used for supporting the floor overhead, as shown distinctly in Fig. 1.

A four-wheeled trolley traverses the jib a distance of 18 ft., and has two flanged and two blind wheels, the latter being keyed to the axle on which are keyed two 45-tooth wheels, engaging a pair of 19-tooth spur gears which in turn are operated by an endless chain thrown over a 14-in. sheave pulley. This arrangement enables the trolley position, with or without load, to be changed at the pleasure of the operator from the floor. Details of the trolley are shown in Fig. 2, which indicates the method adopted for suspending a five-ton motor hoist by means of two U-bolts, chain links and hooks.

In order to overcome the flexibility of the jib, the 10-in. channels were stiffened by placing a No. 54, 10-lb. Carnegie *T* on each side of them as shown at *L*, Fig. 1.

"In taking roughing cuts on cylindrical grinding machines," says Abrasive Industry, "a wide traverse feed should be used, as this will expedite production. The platen travel should be within ⅛ to ¼ in. of the width of the wheel for each revolution of the work. Fine traverse feeds in roughing operations with abnormal depths of cut is not as efficient as a wide feed with a comparatively light cut."

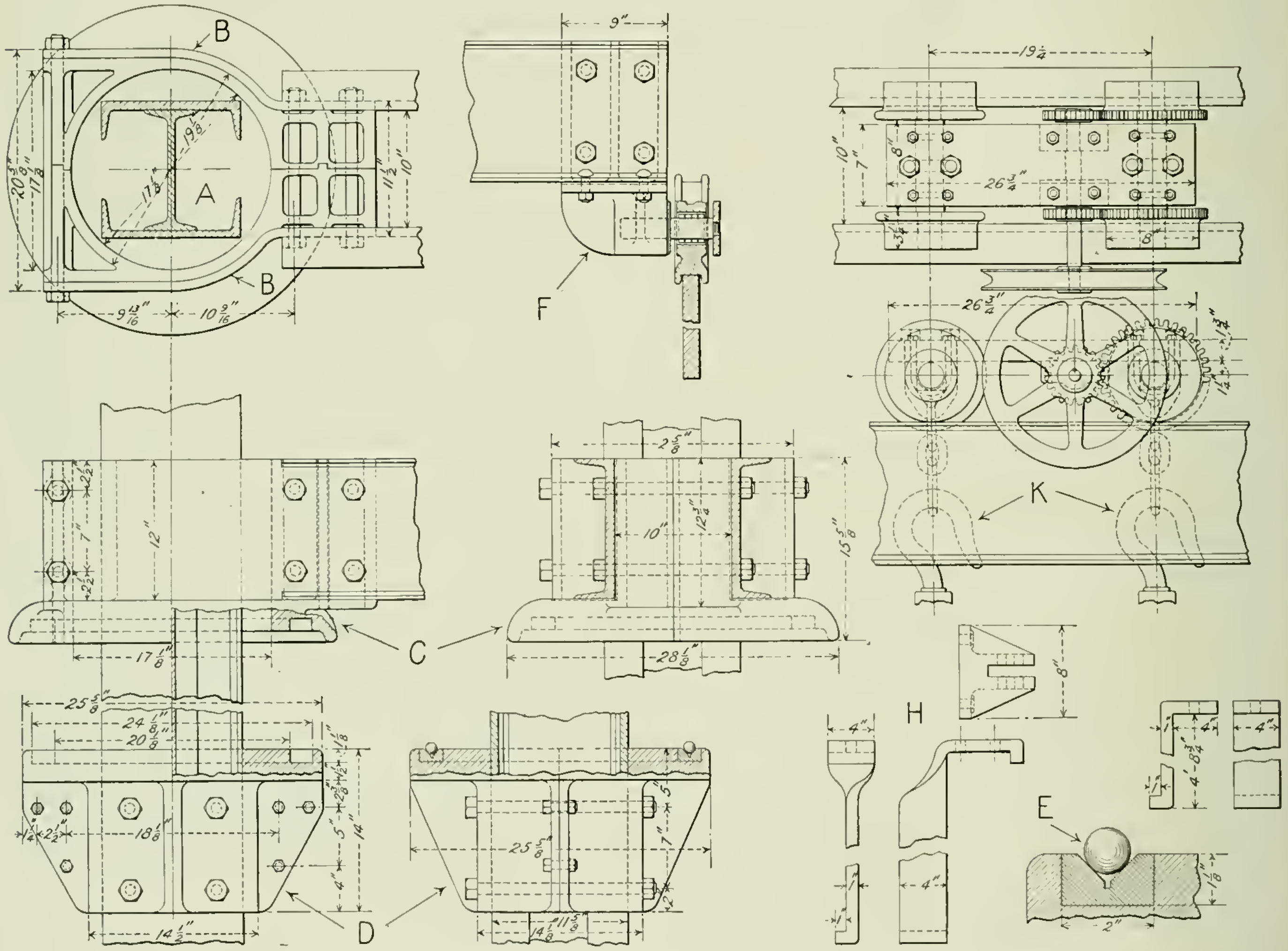


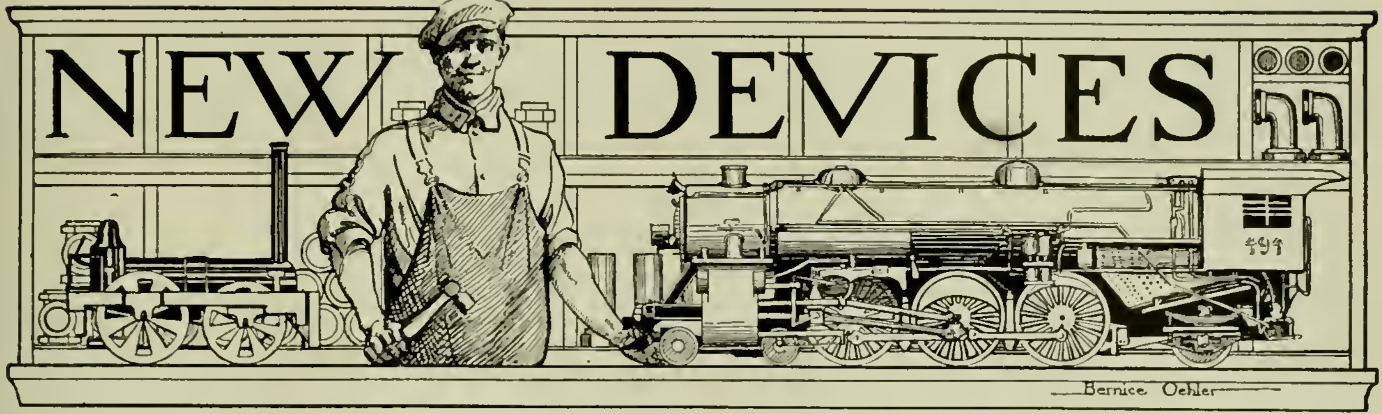
Fig. 2—Details of Column and Full-Swing Jib Crane Arrangement

Keeping Shop Orders Clean.—In spite of the best efforts of any shop, the job tickets and the blueprints following a part through manufacturing processes are very likely to end up entirely illegible. This is not necessarily due to carelessness, as it is impossible to send papers along the route of the average machine part without having them pretty badly mussed up.

The practice of the Barber-Colman Company helps materially in preserving blueprints, job orders, job tickets, etc., routed through the plant. All milling machines, lathes, drill presses, etc., are equipped with a small rod bolted to the machine frame in such a manner as to be within easy reach and sight of the operator while the machine is working, and yet not be in the way. This rod rises 10 or 12 in. nearly vertically from the frame and is hooked at the end. The operator upon receiving a job, puts all papers accompanying it in an ordinary, strong paper clip, hanging the clip on this hook.

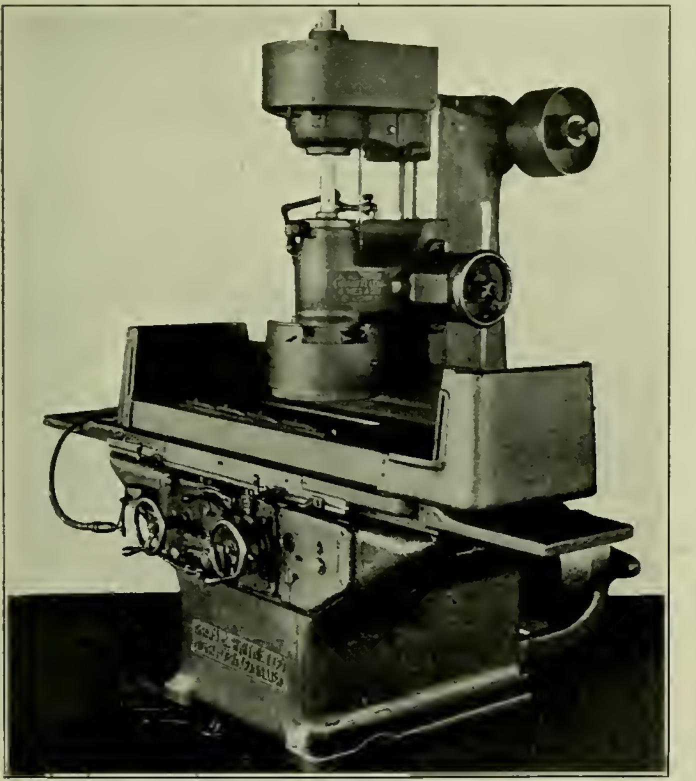
This serves a double purpose. All papers are kept in better condition, and are also more convenient for both operator and foreman. The foreman does not need to ask the operator any questions about the job, as all information is obtainable from the papers hanging on the hook.—*The Melting Pot.*

The production of soft coal increased slightly during the week ended October 15, according to the weekly bulletin of the Geological Survey. The total output is estimated at 9,696,000 tons, an increase of 573 tons over the week preceding.



Vertical-Spindle Surface Grinding Machine

ABILITY to handle work faster and more accurately than planers or milling machines, especially where small amounts of metal are to be removed at a single cut, is a feature of the new vertical-spindle surface grinder made by the Pratt & Whitney Company, Hartford, Conn. The machine is adapted for general surface grinding and for toolroom work on flat machine operations, such as the sharpening of blanking and forming dies. Another distinctive feature is the ability to handle, with equal efficiency, work requiring either a rotary or longitudinal movement. This feature, in conjunction with the simplicity and flexibility of the various work holding devices, makes the machine capable of handling an unusually wide range of work. The grinder is made in three sizes, including 8-in., 14-in. and 22-in.


Pratt & Whitney 14-in. Vertical Surface Grinder

The wheel spindle is supported by two well-proportioned brackets, scraped to correct position on the column, the entire spindle being mounted on ball bearings. The wheel is mounted on a face-plate screwed to the spindle so that it can be easily removed when replacement is necessary, the operator being protected from injury by a strong sheet-metal guard. An additional safeguard is provided by a safety band fitted around the wheel itself.

. The table is of heavily ribbed construction, being equipped with three T-slots, furnishing adequate space for clamping magnetic chucks, special fixtures and in some cases the work itself. The length of stroke and reversal of the table are regulated by dogs, adjustable along a T-slot in the front of the table. A safety dog prevents the table from running off the ways. The table-driving mechanism operates through a safety friction which protects the gearing. The reversing-gears, clutches and drive shaft are hardened and ground to secure the greatest strength and wearing qualities. Two table speeds are provided, the operating clutch being controlled by a handle on the front of the gear box. The hand movement of the table is controlled by a hand wheel on the front of the gear box, which throws an auxiliary, drive pinion in and out of mesh. The wheel head is provided with both hand and power feeds. The power feed operates through a ratchet and pawl connected to the reversing lever. A hand wheel for rapid positioning of the wheel head is provided at the side of the column, the lower spindle head being counterweighted to provide for easy and rapid adjustment.

The main driving belt runs to the spindle pulley over idlers, mounted on well-lubricated roller bearings. The main drive cone runs on a stationary shaft containing felts for oil and is equipped with a bronze bearing. A liberal supply of oil is conveyed to the bearing felts through a hole in the shaft. Arrangement is made for an ample amount of coolant between the face of the grinding wheel and the work and this coolant being supplied at the inside of the wheel, prevents overheating and carries away the particles of metal and abrasive.

Motor drive is recommended on account of the size of this machine and the simplicity of installation and convenience of operation. The bracket carrying the motor is adjustable to permit alinement of the endless belt between the motor pulley and cone. With this type of drive a spring idler is also provided to take up belt slack. A 15-hp. motor is required for the 14-in. machine.

The grinder can be equipped with a rectangular or a rotary chuck, either being plain or magnetic. In either of the rotary chucks, a simple, rugged method of drive is incorporated, so designed that the drive engages automatically in the work position and disengages when the chuck is returned to the non-working position for re-loading. Chucks may be tilted, permitting the grinding of either concave. or convex surfaces. A flexible coupling on the drive shaft takes care of the alinement when mounting.

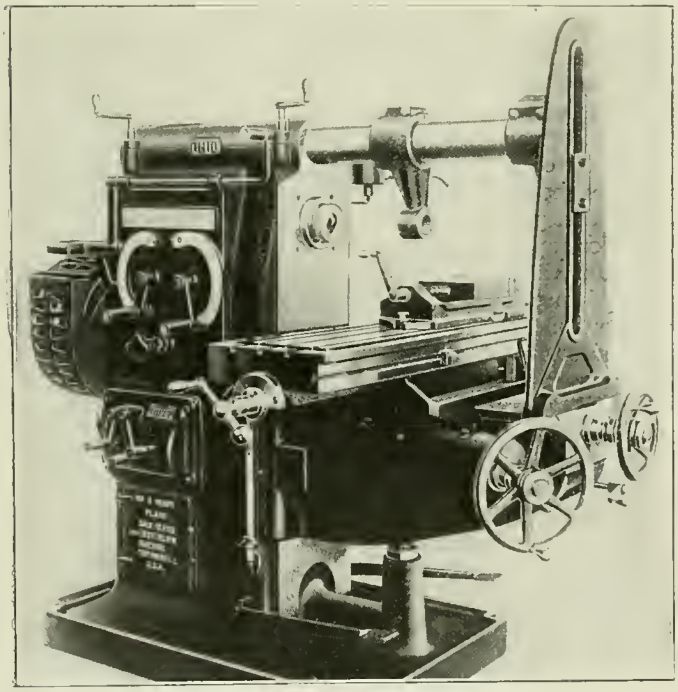
On the 14-in. machine the working surface of the table is

12 in. by 36 in., the distance from the table top to the grinding wheel being 14 in. The diameter of the grinding wheel is 14 in., its height and thickness being 4 in. and 1¼ in. respectively. The spindle speed recommended is 1,155 r. p. m., the rotary chuck speed being 103 r. p. m. Two power table feeds are provided of 34 in. and 142 in. per min. The table feeds per revolution of the spindle are .029 in. and .123 in. Two inches of table feed is obtained per revolution of the hand-wheel. The vertical feed of the head (1 to 10 teeth) is .0002 in. to .002 in. The machine weighs 7,400 lb. net with plain equipment, and the crating material for domestic shipments approximately 1,000 lb. more.

Constant Speed Drive for Milling Machines

The Oesterlein Machine Company, Cincinnati, Ohio, has introduced a complete line of milling machines of the constant speed drive or all-geared type. The line consists of Nos. 1, 2, 2 (heavy), 3, 3 (heavy) and 4 sizes, each size being made either plain or universal as desired. The fundamental object of the new design was to produce a machine with all of the features essential to modern milling, reduce the number of parts to a minimum and increase the strength of necessary parts to a maximum. A study of these machines from that angle is interesting.

The speed mechanism consists of but 15 gears from which 16 geometric speeds are obtained. Only one shaft is employed in addition to the spindle and the pulley shaft. In obtaining 8 of the 16 spindle speeds, power is transmitted through a three or four-gear train. It has been found unnecessary to secure any of the 16 speeds by means of quadrants or similar unstable mechanisms, and this simplification of speed mechanism shows its results in the low power consumption of the machine. The no-load power loss of a No. 2 machine varies from 124 watts (.18 hp.) to 226 watts (.30 hp.) between the extreme spindle speeds of 16 to 384 r.p.m. This power loss includes the feed box at the highest rate of feed and feed mechanism within the knee and may therefore be regarded as practically the entire no-load power loss of the entire machine.



Oesterlein No. 3 Heavy Plain Milling Machine

The speed changes are secured by means of two two-position levers and a four-position knob. The four-position knob controls the selection of four adjacent spindle speeds. All speed changes may be made without stopping the machine. All gears in the machine are made from low carbon forgings, put through an annealing, carburizing and hardening process that produces a gear skin hard and tough. All gears are sandblasted to remove furnace scale and the wire edge of machining operations is removed in order to protect the bearings from this destructive refuse.

The automatic lubrication of the machine is effected without pumps or any extra moving parts. This is accomplished by a system of three reservoirs. The first reservoir is cast in the top of the column and into this reservoir clear, fresh oil is poured. This oil seeps through felt, down tubing to cavities cast under the main spindle bearings, to the intermediate shaft bearings and to the driving pulley. Wicks dip into the cavities under the spindle and carry oil to the spindle bearings proper. Thus it will be seen that only new oil is admitted to the heavily loaded bearings. The oil that passes through these bearings collects in the second reservoir, where it is distributed to the speed gears and minor bearings by splash lubrication. The overflow from the second reservoir passes to the third reservoir, which is the feed box, oiled by splash lubrication.

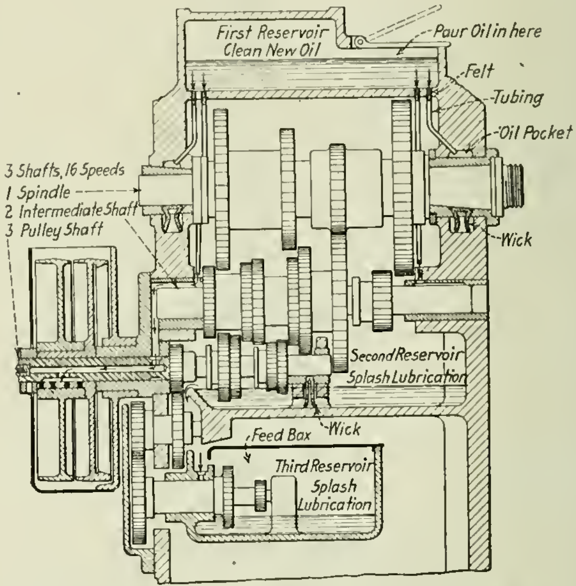


Diagram of Constant Speed Drive Arrangement

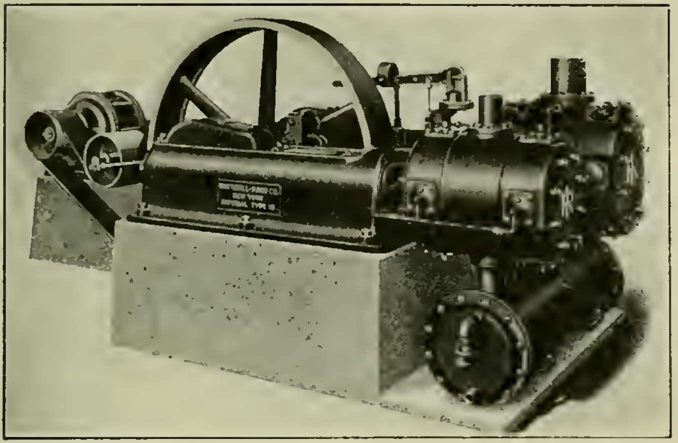
The capacity of the first reservoir is sufficient to supply the machine for about two months of ordinary service. Provision is made for correcting the level of oil in the third reservoir should this reservoir level decrease. This is accomplished by adding new oil and is necessary not more than twice a year. There are no oil holes within the machine to become clogged and any sediment of foreign matter in the oil lays harmlessly at the bottom of the reservoir.

The driving pulleys are 14 in. in diameter and run at 400 r.p.m. Practical use is made of the high belt velocity by controlling the operation of the machine by tight and loose pulley, thus avoiding the expense, wear and complication of a clutch. A brake for quickly stopping the spindle is included in the belt shifter in such a way that the belt is partially carried to the loose pulley and the brake applied to the tight pulley by a spring plunger release. The feed box is driven off the pulley shaft.

A phosphor bronze of from 28 to 32 points scleroscope hardness is used for all bearings and feed nuts throughout the machine. Cumberland ground steel of 45 to 50 point carbon is used for table, cross and vertical screws. The feed box, knee and table are similar to the design developed and used in the company's cone type milling machines.

Five-Step Clearance Control for Air Compressor

An air compressor, having plate valves for both the air intake and discharge and a five-step clearance control for regulating the output has been developed by the Ingersoll-Rand Company, New York. The plate valves used in this type of compressor are supported throughout their entire operation in correct alinement without any form of wearing guide, which insures a long life to the valves.

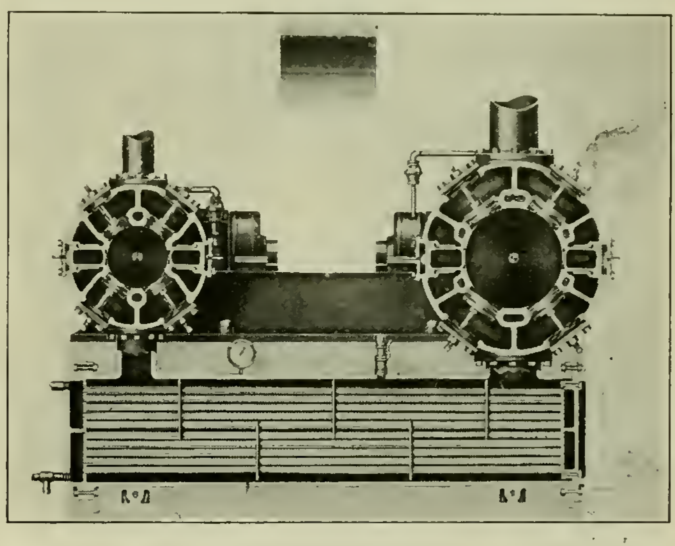


Ingersoll-Rand Short Belt-Driven "Imperial" Air Compressor

The clearance control was originally developed for use on the larger direct connected, motor driven compressors built by the same company, which have been installed in plants where more than 600 cu. ft. of free air per min. is required. With the clearance control, the compressor is automatically loaded or unloaded in five successive steps, obtained by the reduction or addition of clearance space to the air cylinders. Under this system a compressor will operate at full, three-quarters, half, one-quarter and no load and the control is so designed as to secure efficient operation at any step in this range.

A feature of the control is the fact that the clearance pockets are integral parts of the compressor cylinder and the entire regulation is obtained by the control of the volume of air taken in and compressed. The clearance pockets in the cylinder are automatically thrown in communication with the ends of each cylinder in proper succession, the process being controlled by a pre-determined variation in receiver pressure. With the compressor operating at partial capacity a portion of the air is compressed into an added clearance space instead of passing through the discharge valves. On the return stroke this air expands giving up its stored energy to the pistons. The inlet valves remain closed until the cylinder pressure equals the intake pressure, at which point the inlet valves are opened automatically and free air is drawn into the cylinder for the remainder of the return stroke.

On a two-stage compressor, clearance space in proper proportion is added simultaneously for both high and low cylinders giving a constant ratio of compression and maintaining a high compression efficiency throughout the entire load range. All the mechanism for regulating the compressor is independent of the compressor running gear. The new type of belt driven compressor equipped with clearance control is furnished in single stage for low pressures and two stage for higher discharge pressure. The piston displacement capacity for 100 lb. discharge pressure ranges from 610 to 1,505 cu. ft. of free air per min. This new type machine is described in complete detail in Bulletin No. 3042 sent out by the Ingersoll-Rand Company.



Section Through Cylinders and Intercoolers Showing Clearance Valves and Pockets

Knee-Type Surface Grinding Machine

A new design of surface grinder, brought out recently by the Graham Manufacturing Company, Providence, R. I., has been designed with the intention of employing only methods of construction which have been approved by time and practice. Novel, but well tried features, include the adjustable knee, table and pilot wheel, as well as the latest developments in bearings, abrasives, holders and dressers.

The abrasive ring holder is made of pressed steel, light in weight, and all parts are accurately machined to be in accurate balance. The abrasive ring is clamped by drawing a cone-shaped ring into a taper in the body. The adjustment flange screwed upon a large hub sets out the ring as it becomes worn. For dressing the wheel, any standard holder can be fastened on the table and the wheel quickly and accurately trued. Special care has been taken to so design the water guards around the wheel and about the table and trough, that the operator is amply protected from splashing of the cutting lubricant.

Any one of five possible methods of spindle drive is available but the one recommended is to have a motor mounted upon a bracket at the back of the column and attached end-to-end to the grinder spindle by a flexible coupling.

In operation, the actual cutting is ordinarly done on that portion of the wheel indicated by the arrow (Fig. 1) which also shows the direction of revolution. The outside diameter of the abrasive ring is 12 in., the inside or hole, 7 in.; leaving a face 2½ in. wide. Grinding is seldom done on such a wide face, however, but usually on a face from ¾ in. to 1½ in. wide. In a general way the machine may be rated as having a capacity of 6 in. to 12 in. The top of the table will rise to the center of the wheel and drop 7 in. The extreme travel of the table is 16 in. and it can be moved back 3½ in. from the cutting face. Ordinarily, the head is set over just enough to give clearance. This is not sufficient to give a concave surface, though concaving can be done, and it is sometimes desired. Sometimes the head is set perfectly straight, which greatly increases the capacity of the machine, and sparks will fly down at the arrow and upward on the opposite side.

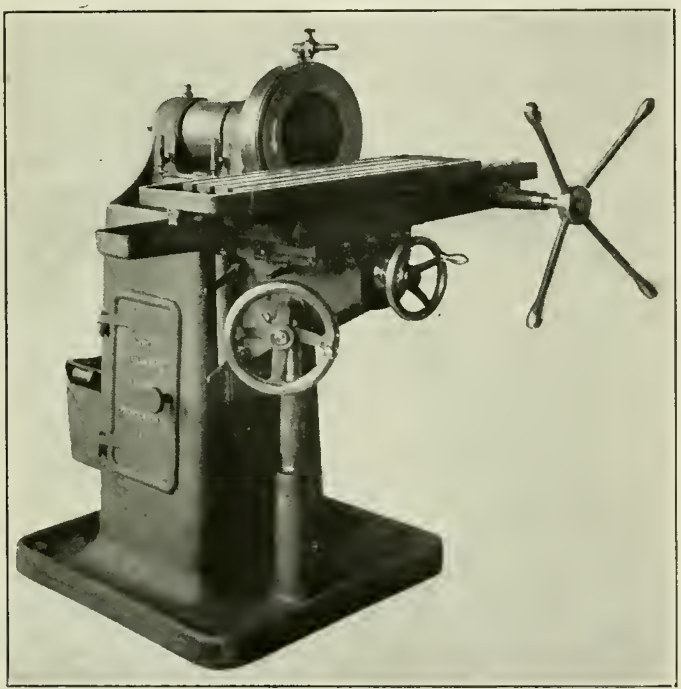


Fig. 1—Graham No. 41 Knee Type Ring Wheel Grinder

The table block sets on the knee and has gibs fitted for movements in two directions. It is also fitted carefully with an adjustable nut that takes the cross-feed shaft and hand-wheel. This is indexed in thousands and regulates the depth of the cut. Ample oiling provision has been made as it is important to have the slides well lubricated. A special feature of the design is the provision of felt-packed dust collars to protect all running parts. Protected glass oilers indicate the height of the lubricant.

The abrasive ring holder is made with a heavy hub or center upon which a body of pressed steel, accurately machined, is fastened. The large portion of the center contains a setting-out nut with flange behind the abrasive ring to provide compensation for wear. The outside diameter of the abrasive ring is caught by a cone-shaped clamp ring drawn by several bolts into a taper machined in the body. The abrasive ring is 12 in. outside diameter, plus or minus .005 in., the height when new being 3 in. and when worn ½ in. or less.

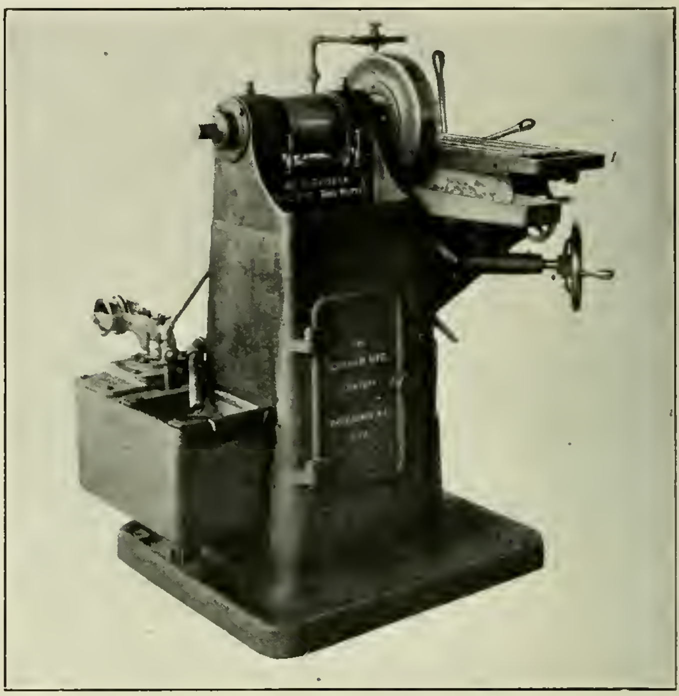


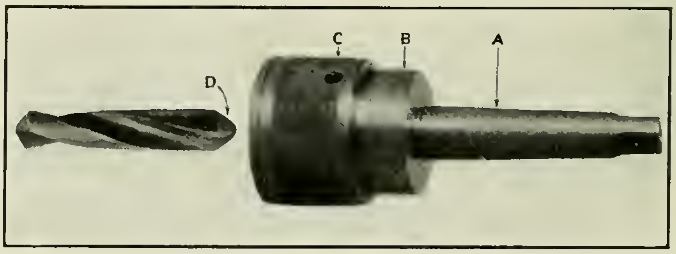
Fig. 2—Rear View of Graham Grinder Showing Tank

Speaking of the machine as a whole, many modifications can be made, magnetic chucks furnished and automatic cross and table feeds applied. The height to the center of the spindle is 42 in., the table working surface being 10 in. by 24 in. and the weight of the machine 2,000 lb. For light work a 5-hp. motor is required driving the spindle at 1780 r. p. m. which gives a surface speed of 3700 ft. per min. on a neutral surface 8 in. in diameter.

Chuck Used With Broken Twist Drills

A DEVICE which makes possible the utilization of twist drills, broken at the shank, has recently been developed by the Wayne Tool Manufacturing Company, Waynesboro, Pa. The device is a chuck, simple in design, and quickly applied and removed without the use of tools. It consists of only six parts; shank *A*, casing *B*, two pawls, two screws and a knurled casing plate *C*, as shown in the illustration.

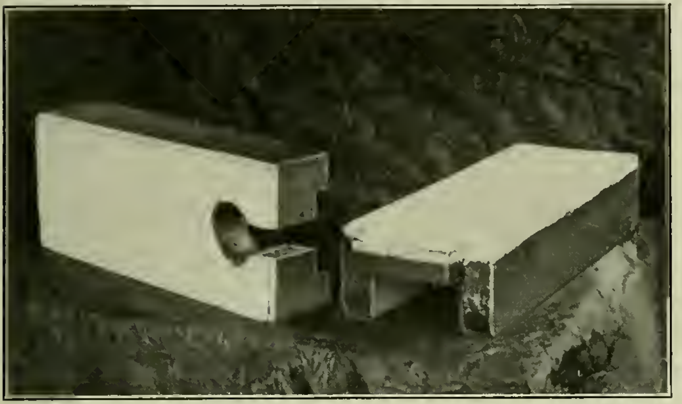
Broken twist drills are prepared for use in the chuck by grinding the broken end to a 60 deg. point as shown at *D* in the illustration. A corresponding recess is provided in the end of the chuck shank. This allows the drill automatically to center itself on being inserted in the casing and by turning the casing plate *C*, the drill is locked in place by means of the two pawls which grip the drill about the grooves. The drill is released for removal by turning the casing in the reverse direction.



Broken Drill Ready for Application in Chuck

Bronze-Faced Driving Box Shoes and Wedges

WHAT promises to work important changes in methods of maintaining locomotive driving box shoes and wedges, effecting important savings in maintenance costs, is the development of bronze-faced semi-steel castings by the Standard Semi-Steel Foundry Company, Clinton, Mo. Shoe and wedge castings have been made of this material in which the bronze faces proved to be 30 per cent harder than ordinary bronze, the backs being made of semi-steel approximately 50 per cent stronger than grey iron. The combination of these two metals affords valuable wearing properties and the strength that is so essential in shoes and wedges. Bronze-faced shoes and wedges, such as are shown in the illustration, have been used for 16 months on two important railroads with no difficulty being encountered due to the separation or loosening of bronze faces under the constant hammering.

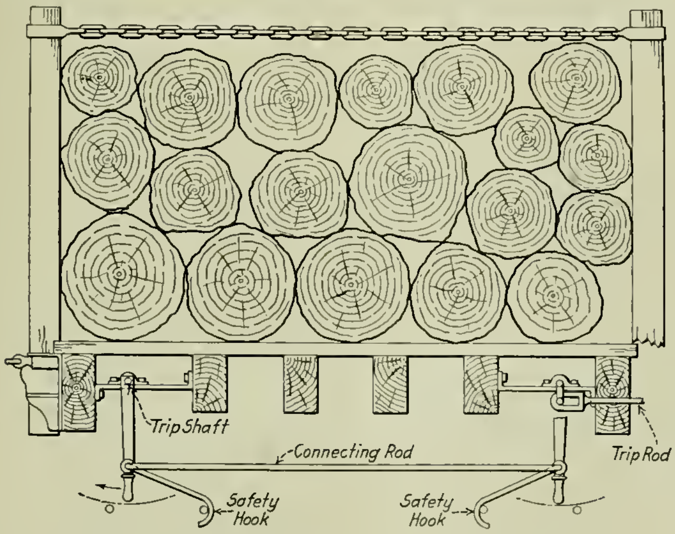

Semi-Steel Shoe and Wedge With Bronze Faces Outlined in Chalk

Different railroads use different methods of handling shoe and wedge maintenance work. Some rivet brass plates to the shoes and wedges and others apply brass to the driving boxes, while in still other cases solid brass shoes and wedges are used. It has been found in the first two methods that the use of bronze-faced shoes and wedges effects a large labor saving and is extremely satisfactory, doing away with the pounding from loose liners as there has never been a case where the bronze separated from the semi-steel. In cases where solid brass is used it has been found that shoes and wedges wear very fast and do not stand up to the work imposed upon them, moreover, the first cost is much greater. The use of the bronze-faced material has been found to be an advantage to the roundhouses inasmuch as a large amount of pit work in adjusting driving boxes and changing shoes and wedges is reduced or eliminated. It has been suggested in cases where a road uses the method of dovetailing driving boxes and then pouring on brass, the change to bronze-faced shoes and wedges can be made by welding a steel plate over the driving box face, thus covering the dovetail slots and enabling the old driving boxes to be used.

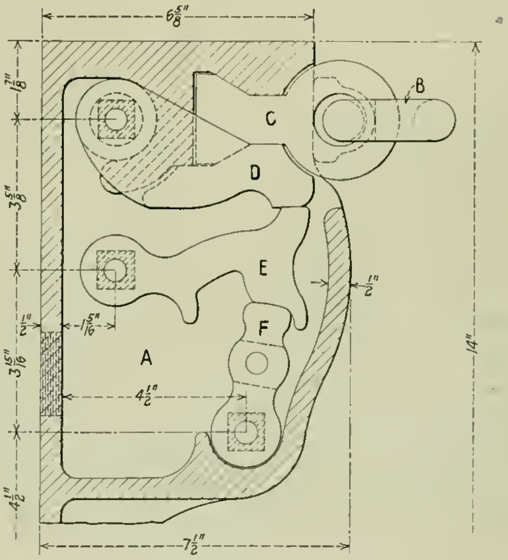
The question of reclaiming bronze from the scrap came up soon after bronze-faced shoes and wedges were developed. After experimenting it was found that by putting the shoes and wedges in an oil furnace, heating them to a little more than cherry red, a blow with a sledge hammer separated the two metals. The cost of reclaiming the bronze was about 25 cents per hundred pounds and it is worth about two dollars per 100 pounds more than ordinary scrap brass. The combination of bronze and semi-steel in one casting is secured by special mixtures and careful molding.

Safety Stake Pocket for Logging Cars

VARIOUS types of stake pockets have been invented for logging cars, the majority of which are equipped with permanent stakes hinged at the bottom and a mechanism which when tripped allows the stakes to swing out and dump the load. Such stakes, however, are used principally on small logging cars. A new type of stake pocket, particularly adapted for use on standard flat cars and having an effective safety feature, has been invented by A. D Adams, Gulfport, Miss. In this design the stake, instead of swinging about a pivot at the lower end, is entirely released at the bottom, when it is desired to dump the load.



Arrangement of Operating Levers and Safety Hook



Details of the Stake Pocket Mechanism

The construction of the stake pocket is shown in one of the illustrations. The entire operating mechanism is placed in one side of the body *A*. Part *B* is a link, one end of which passes through an eye bolt on the opposite side of the stake while the other end is held by the retainer *C*. The wedge shaped end of the retainer is held by lock *D* through the action of latch *E* and trip *F*. The stake fits between the body of the stake pocket and the link *B* which is firmly held in place while the parts are in the position shown. It is evident if the trip *F* is moved to the left, the latch *E* and lock *D* will drop, releasing the retainer *C*. Link *B* is then free to swing in the eye bolt to which it is fastened at the opposite end and will be forced out by the stake, releasing the load.

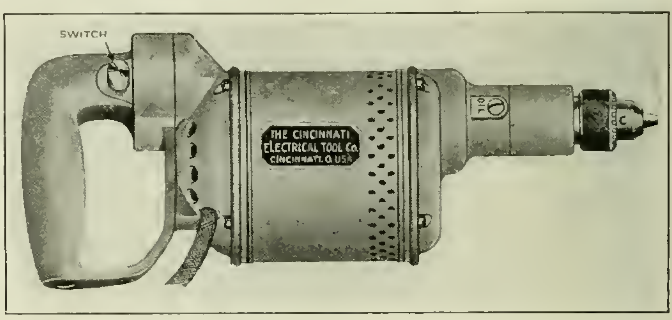
The mechanism by which the release is effected is also illustrated. The trips are operated by trip rods which are connected across the car by rods and levers as shown. The lever on each side has a safety hook which fits over a truss rod preventing unintentional or improper release of the stakes.

When ready to dump the logs, the operator proceeds to the opposite side of the car from which they are to be unloaded, raises the safety hook and pulls the lever to which it is connected. This releases all the stakes on the opposite side of the car simultaneously so that the logs can roll off. As the stakes are chained together at the top, the logs roll out under them, leaving the stakes ready to rearrange for loading again. When the safety hook on either side of the car is raised, it allows the lever to be pulled, releasing the stakes on the opposite side. The arrangement is such that it is impossible to dump logs on the operator, for the safety hook on the opposite side makes it impossible to push the lever toward the center of the car which movement would dump the logs on the side on which the operator is standing.

Ease of Operation Features New Portable Drill

A LIGHTWEIGHT, portable electric hand drill of 3/16-in. capacity with pistol grip is the latest addition to the line of portable electric drills and grinders manufactured by the Cincinnati Electrical Tool Company, Cincinnati, Ohio. This new drill answers the need for a light and practically frictionless but high speed and powerful tool, adaptable to all kinds of light drilling. It is suitable for drilling in steel, brass, aluminum and sheet metal and for car building, window frames, etc. It also makes a very practical tool for wood boring.

While thoroughly simple in construction, the new drill is compactly and substantially built. It is equipped with a universal motor for use on direct and alternating current of the same voltage. The motor housing, end caps and handle are made of special aluminum, insuring minimum weight consistent with strength. The armature and gear studs are mounted on ball bearings which practically eliminate friction. Gears are of special analysis high grade steel. The switch is the Cincinnati quick make-and-break type with 50 per cent overload allowance. It is entirely enclosed in the handle and is operated by a trigger conveniently located in the handle.



Portable Electric Drill With Pistol Grip

Locomotive Throttle Rod Stuffing Box

THE throttle rod stuffing box illustrated is a recent development of the Gustin-Bacon Manufacturing Company, Kansas City, Mo. A view of the new stuffing box is given in Fig. 1 and a particular feature of its construction is that additional valve stem packing can be applied and leaks stopped while a boiler is still under steam pressure.

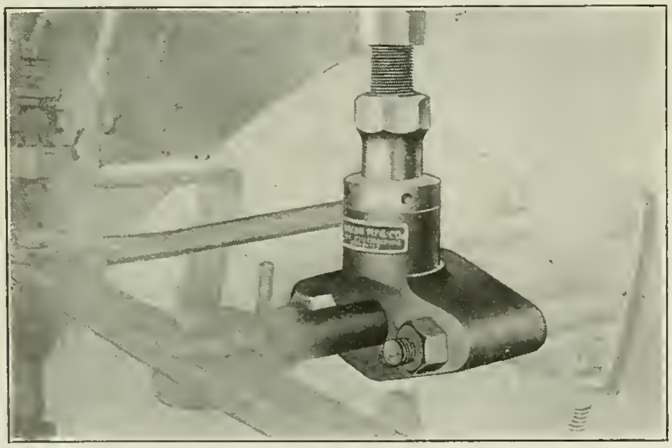


Fig. 1—Throttle Rod Stuffing Box in Position on Boiler Head

Referring to Fig. 2 the construction of the device will be evident. The front section of the stuffing box *F*, fits over the throttle rod and forms a ball joint with the boiler head, being held in place by two stuffing box studs. The main stuffing box *B* forms a joint with the front section by means of copper gasket *G* and is held against the gasket by two bolts shown in the end view. A plunger *P* is arranged to screw into sleeve *S* which is a running fit in spanner nut *N*. The storage chamber *C* is provided to receive the plastic packing

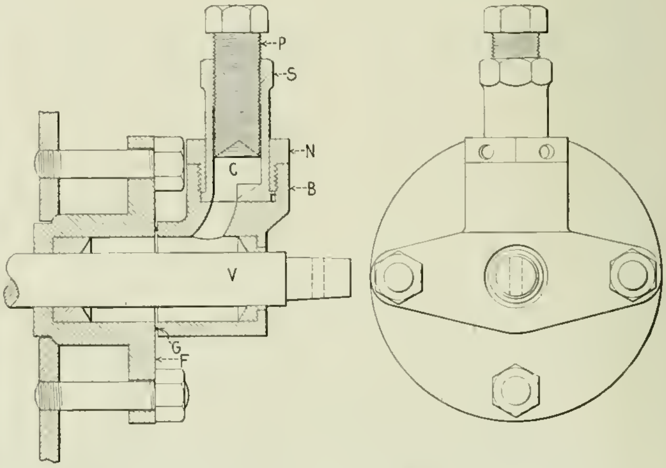


Fig. 2—Details of Stuffing Box Construction

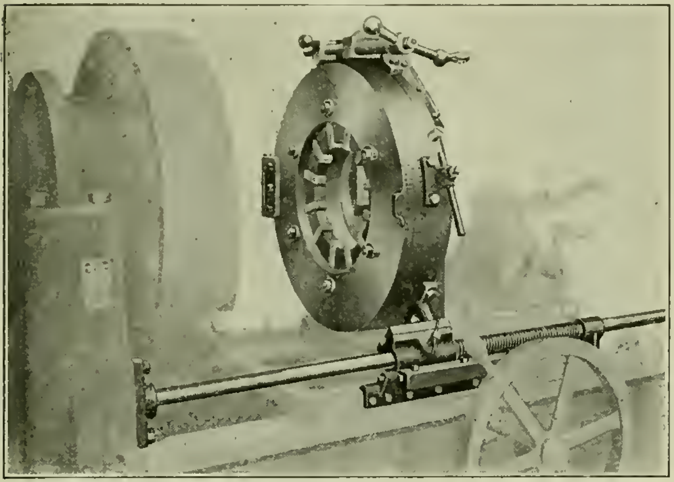
which is forced into the stuffing box through the passageways indicated. The port between storage chamber *C* and the stuffing box can be opened or closed by revolving sleeve *S*.

The normal position of the sleeves when operating is with the port open. Should a leak develop, a slight tightening of plunger *P* will stop it. In case it is desired to furnish an additional supply of packing to the stuffing box with the boiler still under steam pressure, it is only necessary to turn the sleeve *S* until the port is closed. Plunger *P* can then be removed and the storage chamber *C* filled with packing without danger of the escaping steam.

Only one style and size of stuffing box is required since variations in rod diameter can be accounted for by varying the front and back end throat ring bores. G-B plastic packing is composed of small tubes which are forced into a homogeneous mass around the throttle rod by the plunger. Scored and worn throttle rods which are difficult to keep steam-tight on account of set packing not adapting itself to irregularities, are said to cause practically no trouble with the use of G-B plastic packing—which conforms to the shape of the rod when forced into the stuffing box. The position of the plunger in the stuffing box indicates when additional packing is required and this indication is plainly evident to the enginemen or roundhouse engine inspectors.

Receding Die Head for Pipe Threading Machine

In order to cut pipe threads to any desired taper and length, the Williams Tool Corporation, Erie, Pa., is now equipping its power pipe machines with a patent receding die head. In the usual type of head the correct taper can only be cut the width of the die and where a longer thread is required, the only solution is to procure wider dies. This requires special dies and is often impracticable.



Williams Receding Die Head Set Up Ready for Operation

Another threading difficulty is caused by the increased use of soft open-hearth steel in the manufacture of pipe. The cuttings from this grade of steel have a tendency to clog in the teeth of the dies and tear the tops of the thread. This is a characteristic of the steel itself and is a difficulty encountered in threading all products made of this material.

The new head has been so constructed as to cut any degree or length of taper, and also make the cutting easier, having more cutters and teeth designed to reduce chip clogging to a minimum. A narrow die is used and it recedes as it runs on the pipe, opening automatically to give the desired taper and making the length of thread cut independent of the width of the die.

It will readily be seen that the heaviest cutting is at the start, decreasing as the dies run on the pipe and reaching a minimum at the finish. This is exactly the reverse of the action of the old type of head, consequently the cutting will be much easier, using less power and having less tendency to clog. Another feature which tends to give better threads is that the heaviest cutting is done by the front of the dies, the back ends merely cleaning up the threads.

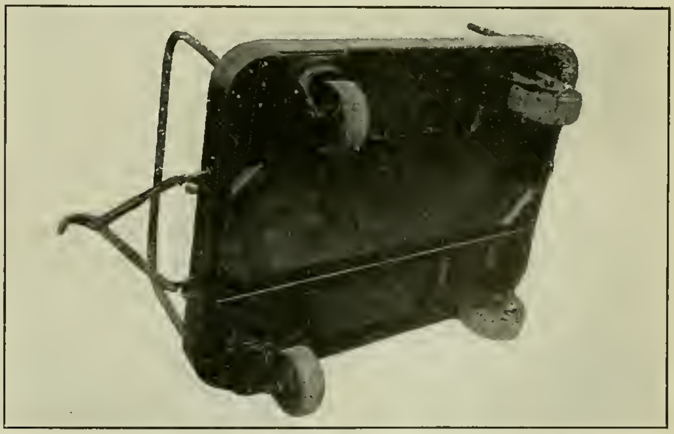
The new Williams receding die head is now furnished with all eight models of pipe threading machines which cover a range of pipe from ¼ in. to 16 in. inclusive.

Heavy Duty Trailer for Concentrated Loads

The movement of heavy concentrated loads such as large castings, etc., constitutes an important handling problem in railway freight stations, warehouses and repair shops. In such work, cranes, trucks, tractors and trailers and various other material handling devices are being increasingly used. For such work the Sharon Pressed Steel Company, Sharon, Pa., has developed a trailer specially designed for heavy duty service with tractors.

The trailer frame consists of four ⅜-in. channel sections which are pressed from ⅛-in. hot rolled open-hearth steel and riveted into one-piece channel section corner pieces pressed to a 6-in. radius. By varying the length of the side and the end rails, the trailer can be made in any length up to 72 in. and in any width up to 50 in. Two additional members, of 3-in. pressed steel channel, run lengthwise beneath the floor and are riveted to the end rails and braced, laterally, to the frame with front and rear pressed steel "V" braces which take the pull of the ⅝-in. steel forged coupler. Either one or two couplers can be used.

The rear wheel and front caster supports are 3-in. pressed steel channels riveted to the side rails and the longitudinal members of the frame. The rear wheel brackets are pressed from ¼-in. steel with two stiffening ribs on each side. The rear wheels are of malleable iron with six double-web spokes and 3½-in. face and are equipped with 3-in. Hyatt roller bearings on a hardened and ground 1-in. shaft.



Under Platform View Showing Construction Details

The front casters are of heavy-duty type, ball and roller bearing equipped, bolted to a ½-in. steel plate which is riveted to the frame. The floor of the trailer is 1¼-in. oak recessed flush in the side and end rails. All frame members are flush on the bottom, thus affording an even support when the trailer is used in connection with a lift truck, such as is now coming into quite common use.

The trailer was recently given a severe test with a load of 8,000 lb., indicating its adaptability to exacting service.

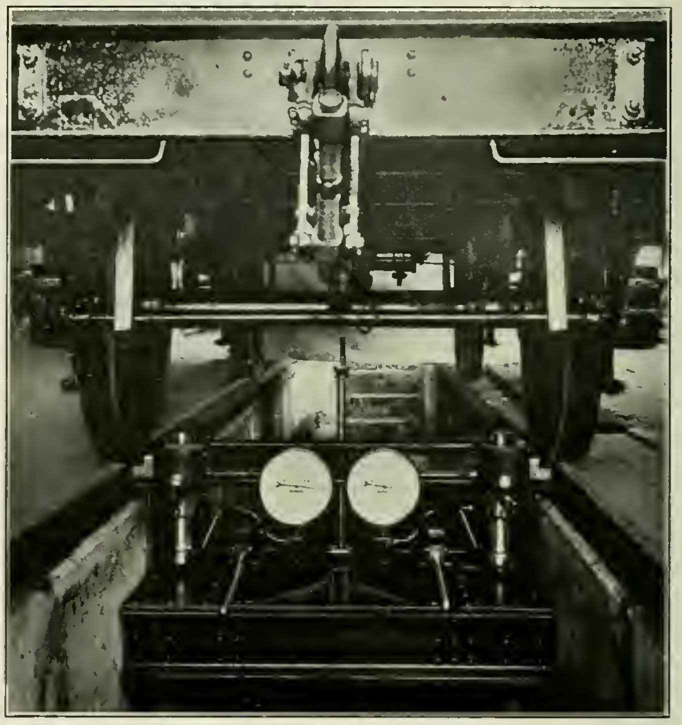
Measuring Locomotive and Car Wheel Loads*

A NEW device for measuring the loads on locomotive and car wheels and finding the pressures with which the wheels bear upon the rails has been developed by Alfred J. Amsler & Company, Schaffhouse, Switzerland, and is being sold in this country by Holz & Company, Inc., New York. As shown in the illustration, the complete apparatus consists of two different parts, the measuring machine proper and the carriage for moving it about under the cars. The carriage is a strongly-braced structure provided with two wheels at each side, and these run on narrow-gage rails set in a pit below the vehicles to be weighed. In this way the cars need not be moved during the weighing operation, and only the measuring machine is moved along on its carriage from one axle to another between each reading.

The weighing apparatus is centered on the upper cross-bar of the carriage and comprises two oil presses, the pistons of which are so accurately fitted in the cylinders that no packing is required to ensure sufficient oil-tightness. The motion of these rams is therefore practically frictionless, and hence the oil pressure acting in the cylinders measures the load on each of the presses. The pistons both act near the ends of a single cross-beam, the projecting lugs of which engage the wheel flanges of the axle to be weighed. These supports are mounted on spherical seatings so that they support the wheel truly at each end. The transmission of the load between the piston and the cross-beam is effected through a suspension cap and spring-centered pin, so that the piston is not acted upon by any side pressure. The cross-beam is in turn attached to the suspension caps by means of pivots so that no side effort can be produced.

The presses are each connected with a hand pump which serves to raise the cross-beam and eventually the car wheels are raised. The oil pressure, acting in each press immediately the wheels are raised, is a measure of the wheel loads, and these are read off on the two pressure gages, graduated in tons. A simple release valve, on being opened, discharges the oil presses and lowers the wheels gently onto the rails. During the load reading, the pistons of the oil presses are rotated slightly by means of the rocking levers, which are connected by the bar at the back. This completely eliminates any friction which might exist between the piston and the cylinder.

A centering rod, running between rollers on the machine base-plate, is provided with an adjustable stop which is set before the weighing carriage is run under an axle. This enables the machine to be brought immediately below the axle to be weighed, then the rod is lowered, and kept down during the weighing operation. It is best to keep it lowered when passing from one axle to another. When not in use the weighing portion of the apparatus may be detached from the carriage and stowed away in a suitable place. Only one screw need be unfastened to free the apparatus which can be lifted by two men. To check the pressure gages occasionally the packing of the pump pistons can be slackened off when they will work without friction. A weight of one pound hung on the hook at the end of the pump handle produces a pressure equal to a load of 500 lb.


Amsler Wheel Load Measuring Device

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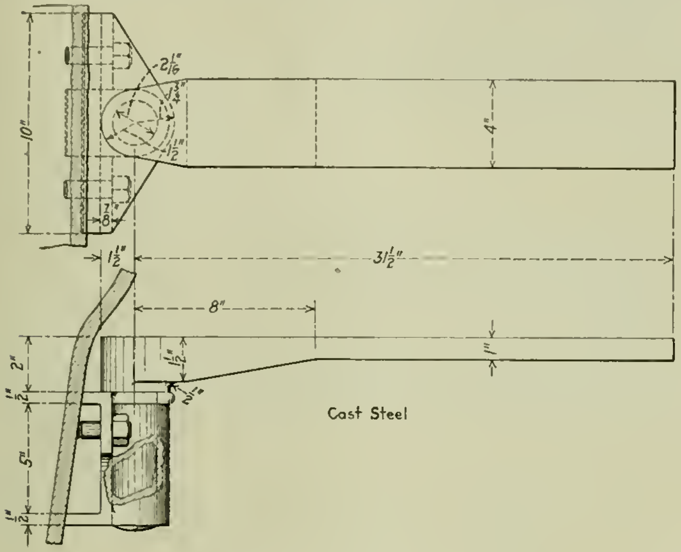
*Abstract of a description in the Railway Engineer, November, 1920.

Easily Detachable Running Board Bracket

EASE of application and removal are features of a recently devised running board bracket which has the additional advantage of swinging back against the boiler in case of a wreck, thus avoiding pulling out studs with consequent danger of scalding with hot water and steam.

The ordinary type of running board bracket is usually formed from a bar of iron or steel bent to approximately a right angle and fitted to the boiler. The part coming in contact with the shell of the boiler is secured with studs to the shell and the outer part of the bracket helps support either the cab or running board. In the event of a locomotive being side-swiped, if the side of the cab or running board is struck, the running board bracket will often be pulled off with sufficient violence to pull out the studs, permitting live steam to escape and scald anyone in the immediate vicinity. Even if the studs are not torn out of the boiler or broken, they will have to be cut off to release the damaged bracket, and there is considerable expense in removing, repairing and replacing a one-piece running board bracket.

In the new running board bracket design illustrated, the hinge principle has been adopted. The base or socket portion of the bracket is secured to the boiler shell by means



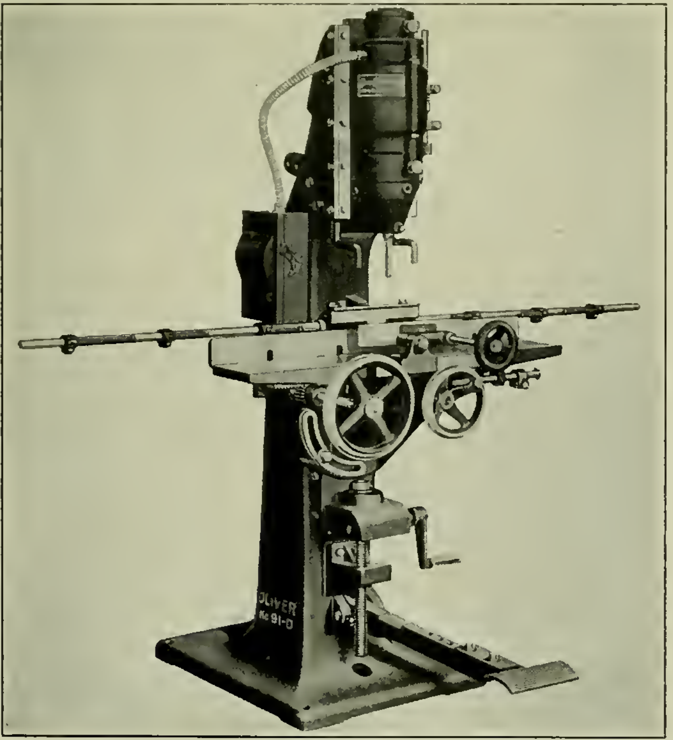
Hinge-Type Running Board Bracket

of studs, or in the usual manner. That portion of the bracket which supports the cab and the running board is at its inside end formed in the shape of a pin at right angles to the main or flat portion of the hanger to which the running board and cab are fastened. This pin enters the socket which is bolted to the boiler shell, thus forming the completed bracket. The running board and cab are riveted or bolted to the bracket and in the event of a side swipe or other accident affecting the running board, the weakest portion is the running board itself or the bolts which fasten it to the bracket. These are broken or sheared off and the bracket simply folds against the side of the boiler without disturbing the studs which enter the boiler shell. Even if the equipment coming in contact with the locomotive approaches so closely to the boiler as to come in contact with the socket portion of the bracket, the socket is so designed as to present a small flat surface to receive the blow, and it would rather cause it to glance off. In other words, any accident which would damage the socket or tear out the studs securing it to the boiler would be almost certain to damage the boiler itself.

The device has performed satisfactorily under service conditions and in addition to being a safety device it effects a considerable saving in the cost of repairing a locomotive that has been side-swiped. In the majority of the cases the damaged running board would simply be removed, the brackets turned back to their normal position and another running board bolted in place. In case the lagging must be removed the time saving feature of this device is readily apparent. The fact of the running board being bolted to the cab's bracket or tail board together with the weight of the cab itself prevents any movement of the running board in ordinary service. A patent on this running board bracket has been issued to C. B. Baker, 3865-A Flad Avenue, St. Louis, Mo.

Direct Motor Drive Applied to Mortiser

AN interesting application of direct motor drive to a vertical hollow chisel mortiser is shown in the illustration. The motor operates at a speed of 3,600 r. p. m. on either two or three-phase, 60 cycle, alternating current and is built into the mortising head or ram of the machine, this construction providing a shaftless motor.



Oliver Motor Driven Hollow Chisel Mortiser

The housing for the motor forms the motor head and the motor itself does not have any bearing, its rotor being mounted directly on the spindle, which runs in ball bearings. The motor is connected to a safety-first, enclosed starting switch with fuses, by means of a flexible conduit. The machine itself is equipped with a compound table having hand-wheel rack and pinion feeds and a clamp for the work. The usual bushings, wrenches and similar equipment are provided.

As in the usual construction of hollow chisel mortisers, the cutting tool is operated by means of the foot treadle shown in the illustration. The working table is capable of movement by means of the large hand-wheel shown, the motion being transmitted through a small pinion and rack underneath the table. Arrangement for swiveling the table in case it is desired to mortise at an angle is made by means of the quadrant and locking nut shown in the illustration.

The principal advantages of this new construction is in the elimination of a countershaft and new pulleys and belts. Floor space is saved and the machine may be arranged in the shop regardless of line shafting. The machine is self-contained and is said to be cheap to operate on account of the efficient motor drive. The cost of up-keep is also small. This mortiser has been developed and placed on the market by the Oliver Machinery Company, Grand Rapids, Mich.

Regulating Fire Thickness.—Finding that the horsepower needed was not being developed in his power plant, an eastern manufacturer had curves made of the boiler performance. In one set of curves the horsepower developed and the over-all efficiency of the boiler were plotted against the thickness of fire.

From this curve the engineer discovered that there was one particular thickness of fire where the efficiency was greatest. With this thickness the greatest horsepower could be developed, but the curve fell off steeply on each side of this point, showing that a slight variation in thickness could develop considerable power.

The surprising fact was that the thickness at which the boiler operated most effectively was not that at which the firemen had thought best results were obtained.—*Factory.*

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WE GUARANTEE, that of this issue 7,700 copies were printed; that of these 7,700 copies 7,018 were mailed to regular paid subscribers, 11 were provided for counter and news company sales, 229 were mailed to advertisers, 8 were mailed to employees and correspondents and 434 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 100,550, an average of 9,141 copies a month.

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Mechanical Convention at Atlantic City

The Executive Committee of the Railway Supply Manufacturers' Association met at the Waldorf-Astoria Hotel, New York City, October 26, 1921. The situation was thoroughly discussed regarding the meeting and exhibits of the Association for 1922. The letter ballot as to the preference of all members indicated a three-to-one vote in favor of the meeting and exhibits. The letter ballot and reports from the various members of the committee, representing all parts of the United States, showed also that the members were decidedly in favor of going to Atlantic City for the meeting and exhibits. A formal vote was taken and it was unanimously decided to hold the 1922 meeting and exhibits in Atlantic City.

The General Committee of Division 5—Mechanical, American Railway Association, held a meeting in New York City on the afternoon of October 6, and decided unanimously to hold its annual convention at Atlantic City, June 14 to 21, 1922. Division 3, American Railway Association (Purchases and Stores) will be invited to hold its annual meeting at the same time and place.

A fire which swept the Chicago, Rock Island & Pacific shops at Pratt, Kan., on October 7, destroyed the repair tracks, car sheds, carpenter shops and 25 box cars; estimated damage $200,000.

Abolition of the United States Railroad Labor Board and all other existing national labor adjustment boards was urged in resolutions adopted by the 28th annual convention of the National Implement and Vehicle Association at the Congress Hotel, Chicago.

The Pennsylvania Railroad, since May 15, has taken on about 14.000 men, the total number of employees now being 199,000, as compared with 184,625 on May 15. President Samuel Rea, in giving out these figures, said: "It is the purpose of the Pennsylvania to co-operate as far as possible with President Harding's efforts to reduce unemployment. It is our hope that still more men will be needed. We intend to utilize the additional men chiefly in putting our idle cars in order prior to the coming of winter. We have at present on the Pennsylvania system 82,149 idle cars, of which 46,691 have been stored without being repaired. None of the latter are required for current use, or, as far as can be foreseen, are likely to be needed this fall. In all probability it might be perfectly safe to defer their repair until next spring, but we feel that if we put them in order we shall not only be prepared for a revival in business but shall also be assisting in President Harding's endeavor to improve the general employment situation."

Mechanism in Constant Use Without Injury Held Safe

The New York Court of Appeals holds that, when it comes to a question of proper condition and safety under the Boiler Inspection Act, mechanism which has been in constant use for years without causing injury must be considered proper and safe until some notice or occasion indicates its danger and insufficiency.—Ford v. McAdoo (N. Y.) 131 N. E. 874.

Anthracite Shipments in September

Shipments of anthracite for September as reported to the Anthracite Bureau of Information, amounted to 5,519,412 gross tons, against 5,575,115 tons in August. The loss in production due to the shutting down of some mines in the Scranton district that cannot be operated under the provisions of the Kohler act, was something over 200,000 tons, about three-fourths of which loss was made up by increased shipments from other districts. The total shipments for the coal year beginning April 1, have amounted to 34,350,584 tons, as compared with 33,479,753 tons for the corresponding period in 1920, a gain of 870,831 tons.

Fraudulent Pay Checks

Three men arrested at Pittsburgh, Pa., and brought into court on October 7, on charges of conspiracy to defraud the Baltimore & Ohio Railroad, were found to have cashed a large number of counterfeit pay checks; and to identify themselves, when making purchases, they used counterfeit railroad passes, written on blanks which they had printed. All three pleaded guilty. One was an employee and another a former employee; and two other men, including a printer, are yet to be caught. In passing checks amounting to $1,412, the thieves had received more than $1,000 in change.

Convention of American Electric Railway Association

The report of the Committee on Heavy Electric Traction of the American Electric Railway Association was presented at the annual convention, held during the week beginning October 3 at Atlantic City, N. J. The committee outlined the work in progress by the A. E. R. A. and other societies in America interested in heavy electric traction, and suggested that much of the present duplication of work should be done away with. The term heavy electric traction was defined as it applies to locomotives and multiple-unit equipment, a progress report on electric switching locomotives was made, comparative advantages of locomotives and multiple-unit cars were outlined and much data presented in the form of chart, tables, and a bibliography.

Westinghouse Receives Additional Order From Chile

The Chilean State Railways have ordered six express passenger electric locomotives from the Westinghouse Electric International Company. This equipment is in addition to the 33 electric locomotives and other electrical material the contract for which the Westinghouse Company received several weeks ago, as noted in the October issue. This equipment will be used in electrifying the Chilean State Railways from Valparaiso to Santiago and Los Andes, a total line mileage of 144 miles.

Electric Motive Power for the Paulista Railway

A total of 16 electric locomotives, six for passenger and ten for freight service, were purchased in the United States for the Paulista Railway, Brazil. Two passenger and two freight locomotives were supplied by the Westinghouse Electric International Company, and the remainder of the locomotives by the General Electric Company. The freight locomotives are now in Brazil ready for service, and the passenger locomotives have been completed and shipped from the works of the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pa.

Car Repair Contracts

The Maine Central is having repairs made to about 800 box cars at the shops of the Laconia Car Company, Laconia, N. H.

The Michigan Central has awarded a contract for the repair of 500, 40-ton underframe box cars and 250, 50-ton steel twin hopper cars to the Illinois Car & Equipment Company, Hammond, Ind.

The Cleveland, Cincinnati, Chicago & St. Louis has awarded a contract for the repair of 500, 50-ton all-steel box cars to the American Car & Foundry Company, the work to be done at the Madison, Ill., plant.

The Erie has entered into a contract with the Greenville Steel Car Company, Greenville, Pa., for the repair of 1,000 steel coal cars of 50-ton capacity. This is in addition to the repairs on 1,000 cars previously let to the same company.

The New York Central has awarded contracts for the repair of 500, 40-ton steel underframe box cars to the Streeter Car Company, Kankakee, Ill., to the Standard Steel Car Company, Pittsburgh, Pa., and to the Ryan Car Company, Chicago. It has also awarded contracts for the repair of 500, 50-ton steel hopper cars to the Buffalo Steel Car Company, Buffalo, N. Y., to the Detroit, Mich., plant of the American Car & Foundry Company, and to the Ryan Car Company; and for 250 cars of this type to the Steel Car Company, Euclid, Ohio; also for 500 box cars to the Koppel Industrial Car & Equipment Company, Koppel, Pa.

Unemployment Conference

The President's Conference on Unemployment, after creating a standing committee with authority to convene the full conference at any time and to continue its work through subcommittees during the continuance of the emergency, concluded its sessions at Washington on October 13. The conference adopted a general program of emergency measures outlining means of affording temporary relief during the coming winter and more fundamental methods for reviving business and preventing seasonal unemployment and depression in the future, as well as a number of committee reports in amplification of the general principles expressed.

Railway Fire Prevention Association

The eighth annual convention of the Railway Fire Prevention Association opened at Chicago, on October 18. The meeting was opened by President W. F. Hickey in the presence of about 150 members and guests and was addressed by Alfred H. Erickson, assistant corporation counsel of the city of Chicago, who represented the mayor of the city in welcoming the convention. The meeting was also addressed by J. E. McDonald, chief of fire prevention of the city of Chicago, who gave a short account of the history of fire prevention in Chicago and congratulated the railroad association in having taken so prominent an interest in fire prevention.

Open Saginaw Million Dollar Terminal

Pere Marquette officials and members of the Saginaw Board of Commerce formally opened the new million dollar terminal at Saginaw, Mich., on October 11. The dedication of the new buildings, followed by congratulatory speeches by members of the Saginaw Chamber of Commerce, marked the opening. The new work consists of a thirty-stall engine house, a machine shop, a power house having a 1,000-horse-power capacity, a 100-ft. turntable, a 500-ton coal dock, a cinder conveyor with electrically-operated ash handling equipment, two water tanks, a storehouse, and a general service building.

Bad Order Cars

On October 1 the Car Service Division of the American Railway Association reported 364,372 cars in need of repair, or 15.8 per cent of the cars on line.

Surplus Serviceable Cars

The Car Service Division of the American Railway Association reported a total of 201,153 surplus freight cars on September 23. This total, however, showed decreases of 28,733 and 29,450 cars during the weeks ended October 1 and October 8 when the totals were 172,420 and 142,970 cars, respectively.

Freight Car Loading

According to the weekly report of the Car Service Division of the American Railway Association, the total number of cars loaded with revenue freight during the week ended September 24 was 873,305, an increase of 19,543 over the previous week. This was the largest loading for any week since November 20, 1920, but was 134,804 cars below the total for the corresponding week of 1920.

During the week ended October 1, a total of 901,078 cars were loaded, 27,773 cars less than were reported for the preceding week.

There was a reduction of over 5,000 cars in the freight car loading for the week ended October 8 as compared with the previous week. The total was 895,740 as compared with 1,011,666 in the corresponding week of 1920 and 982,171 in 1919.

Shop Construction

Chicago, Burlington & Quincy.—This company has awarded a contract for the construction of a ten-stall brick roundhouse and a 100-ft. turntable at Centralia, Ill., to Jos. E. Nelson & Sons, Chicago.

Atchison, Topeka & Santa Fe.—This company will construct several extensions to its machine shops at San Bernardino, Cal., at an estimated cost of $224,000. It will also install a boiler washing plant in connection with its shops at this place. The same company will construct a blow-off line in the roundhouse at Cleburn, Tex., and a similar one in its roundhouse at Temple, Tex., to cost about $11,000 each; a dike for protection against floods will be constructed in the rear of its engine house at La Junta, Colo.; estimated to cost about $17,000; and a similar protection against floods will be constructed at Canadian, Tex., to cost about $25,000.

Imprisonment for Falsification of Car-Repair Bills

Theodore W. Krein, general manager of the Muscatine, Burlington & Southern, pleaded guilty to an indictment charging him with falsification of car repair records and accounts in violation of the Interstate Commerce Act, in the United States District Court at Davenport, Iowa, on October 6 and was sentenced to one year and a day in the federal penitentiary, and fined $3,000. The railroad company and Krein were charged with falsifying the company's records to show that the railroad had made repairs to cars of other railroads when no such repairs were actually made. Fraudulent bills based upon these records were rendered against other railroads and in this manner approximately $30,000 was collected from other carriers during the year 1919 for car repairs which were not made. Nearly all of this amount was collected from railroads operating under federal control and therefore was a fraud upon the government; the Muscatine, Burlington & Southern was not under federal control during that period. The prosecution followed an investigation by the Interstate Commerce Commission.

This road is 54 miles long, extending from Muscatine, Iowa, south to Burlington. It has six locomotives and 22 freight and passenger cars.

Extension of Time on Interchange Rule Three

The mechanical division of the American Railway Association, in circular No. V-216, announces the extension of the effective date of section f of Rule 3 of the interchange rules, to January 1, 1922. As it now stands this section of the rule requires that after October 1, 1921, no cars carrying products which require the use of salt with ice, and equipped with brine tanks, shall be accepted in interchange unless provided with a suitable device for retaining the brine between icing stations. The extension of time has been made in accordance with the recommendation of the Committee on Car Construction, in view of the fact that not all refrigerator cars with brine tanks have yet been equipped to meet the requirements of the rule.

Activity of the Krupp Works

According to press dispatches, W. T. Daugherty, trade commissioner at Berlin, has made the following report concerning the activity of the Krupp Works:

"In June, 1921, the combined Krupp plants had about 99,000 employees, working eight hours a day, while the production had passed from the pre-war mass manufacturing stage to refining production. Today, instead of manufacturing parts for locomotives, for instance, Krupp is manufacturing the locomotive entire.

"It is pertinent to note, in this connection, that among other finished goods of varied description, Krupp's Essen plant is now turning out a locomotive and a train of eight steel 15-ton freight cars for each working day of the year.

"Production is organized vertically, Krupp products being finished refined, from the crude raw materials, while all intermediate stages between the raw material and finished production are combined in this enterprise. A selling organization exists in addition."

The Oldest Illinois Central Locomotive

The Mississippi, the first engine ever used on the Illinois Central system, was exhibited during the month of September, at the Indiana State Fair, Indianapolis, Ind.; the Kentucky State Fair, Louisville, Ky., and the Interstate Fair at Sioux City, Iowa. It was also shown at the National Implement & Vehicle Show at Peoria, Ill., until October 8.

This engine was built at Natchez, Miss., in 1834, the parts having been imported from England to be assembled there. Its cylinders are 9½ in. by 16 in., and it weighs 14,000 lb. It is said that the entire cost of the engine was less than $2,000. The newest locomotive bought by the Illinois Central this year weighs 382,000 lb., has cylinders 30 in. by 32 in., and its cost was $88,819.

The Mississippi was first used on a line between Natchez and Foster, Miss. (later acquired by the Illinois Central), in 1836, 1837 and 1838. There are no records between 1838 and 1873, but in 1873 and 1874 the Mississippi was in service on a line between Warrenton, Miss., and Vicksburg. In 1874, an engineer, John Rogers, put the Mississippi on a side track to rest for the night, but forgot to close the throttle, with the result that the engine ran into a deep mud bank, where it lay until 1880. From 1880 to 1890, it was used as a switching engine in a gravel pit at Brookhaven, Miss. The engine was given a general overhauling in 1892 and was exhibited in the Transportation Building of the World's Columbian Exposition at Chicago in 1893. It traveled from McComb, Miss., to Chicago under its own power. It was also on exhibition at the St. Louis World's Fair in 1904.

Proposed Wage Cut on Scottish Railways

C. T. Cramp, industrial secretary of the National Union of Railwaymen, addressing railway employees at Edinburgh, said that the Scottish railways have proposed the abolition of the increases in wages granted by the National Wages Board in June (averaging $1.25 per week), and of the special payment for night duty; also that minors shall not receive the pay of adults until they reach the age of 21, according to the Times (London). There are also proposals to abolish the eight-hour day, and substitute 10 hours in many classes, with a "spread" in some grades of 12 hours.

The companies have agreed, he continued, on condition that the employees give up the National Board's award on wages, that they will withdraw their other proposals, and in the event of this offer being rejected, they will go, first to the Central, and afterwards, in the event of disagreement, to the National Wages Board, with the whole of their original proposals. There could be no strike until one month after the National Wages Board has issued its award.

The meeting passed a resolution, expressing the opinion that the proposals were entirely unacceptable, and recording dissatisfaction at the financial statement made by the companies as the reason for proposed changes. The meeting asked for information regarding the allocation of the $25,000,000 set aside by the government for the relief of companies having a deficit because of the conditions of the national settlement, and urged on the union executive the desirability of preserving the principle of national negotiations.

Austria Plans Extensive Electrification

On July 23, 1920, a bill passed the Austrian National Assembly which authorized the electrification within a period of seven years of 405 miles out of the 2,780 miles of railway lines administered by the Austrian government and further contemplates the electrification of 706 miles more within a second period of seven years. If this is done, 1,111 miles or 40 per cent of the Austrian State Railway will have been electrified. The remaining lines by reason of the peculiar traffic will probably not be electrified at all.

So far 27 locomotives—15 passenger and 12 freight—have been ordered from Austrian factories (Brown Boveri, A.E.G., Union and Siemens-Schuckert). This is about one-eighth of the locomotives needed for operation on all lines to be electrified. The passenger locomotives will be of the 2-6-6-2 type and the 2-6-2 type. The 2-6-6-2 engines will operate at a speed of 31 m.p.h. The capacity of these locomotives is about 25 per cent greater than that of the five driving axle steam locomotives now used. They have a rated horsepower of 1,850 at 30 m.p.h. and an overload capacity of 3,000 hp.

The freight locomotives will be of the 0-10-0 type with a rated capacity of 1,000 hp. at an average speed of 18.5 m.p.h. and an overload capacity of 2,000 hp. The cars to be used in the trains operated by electric locomotives will be the same as used for steam operation.

Argentina Buys Freight Cars

According to Commerce Reports, word has been received from Commercial Attaché Edward F. Feely, of Buenos Aires, reporting that the lowest bids offered by each of the following nationalities, as covering railway cars, under tender at Buenos Aires, were as follows:

	Gold pesos per car*
Lowest German bid	3,484
Lowest American bid	4,580
Lowest Belgian bid	5,000
Lowest British bid	5,900

*Gold peso = $.96 at par.

Further word has been received which indicates that the authorities of Buenos Aires have decided to increase the number of cars which they intend to purchase at this time. The original bids covered 70 of the above cars, but at the time of placing the order it was decided to increase the quantity to 100 cars, and the business has been awarded to a firm in Breslau, Germany, under the name of Linke Hoeman, the price being 3,290 Argentine gold pesos each.

This transaction is peculiarly interesting as showing the position of American manufacturers compared with Belgian and British makers who are obviously not in a favorable position with regard to such equipment, although the design of the cars used on the railways of Argentina resembles European practice more closely than the American designs.

This incident also raises the question as to whether the German manufacturers will be able to make prompt delivery of materials of satisfactory quality. Recent experience in other foreign markets suggests that serious difficulty in this connection may result.

American Railway Association

The regular meeting of the American Railway Association will be held at The Waldorf-Astoria, New York City, on Wednesday, November 16. Reports of divisions of the associations are expected to be presented as follows:

Division I.—Operating; Freight Station Section; Medical and Surgical Section; Protective Section; Safety Section; Telegraph and Telephone Section.

Division II.—Transportation.

Division III.—Traffic.

Division IV.—Engineering, Construction and Maintenance Section; Electrical Section; Signal Section.

Division V.—Mechanical; Equipment Painting Section.

Division VI.—Purchases and Stores.

Division VII.—Freight Claims; Car Service Division; Joint Committee on Fuel Conservation; Joint Committee on Automatic Train Control; Conference Committee on Grain.

Copies of the reports will be forwarded to members in advance of the meeting.

Machine Tool Builders' Convention

The twentieth annual convention of the National Machine Tool Builders' Association was held October 18, 19 and 20 in the Hotel Astor, New York. A considerable proportion of the membership was in attendance at the opening session when H. Tuechter, president of the association, read his opening address. The president's address was of considerable length, devoted to many details of the work of the association, and yet presented in such a forceful way that it was listened to with keen attention by all those present. The possibilities in the way of standardization of tools, improved standard methods of cost accounting and the value of the statistical service being developed by E. F. Du Brul, general manager of the association, were pointed out. It was proposed to make this statistical service a business barometer to guide the members of the association in the conduct of their business. The president's address was followed in the afternoon by addresses by Charles L. Underhill, congressman from Massachusetts, on "How Present Political Policies Affect Business"; Professor Jordan of New York University on "Business Cycles" and C. L. Cameron and E. F. Du Brul on "What Things Should Machine Tool Builders Do and What Should They Avoid at Various Stages of the Cycle." The second day of the convention was devoted to committee meetings and the third, to addresses of general interest and value followed by an executive session which considered unfinished business and elected officers for the ensuing year. Officers of the association for the year 1921 were re-elected for 1922, the only change being in the election of Howard W. Dunbar, Norton Company, Worcester, Mass., as secretary.

Railway Wages in Great Britain

The average weekly earnings of railway employees in Great Britain prior to the war in 1914 was 25 shillings a week (about $6 at par exchange). Many increases were granted as living costs rose—at first by granting bonuses and later by making these bonuses a part of the regular weekly wage. By April 1919, the average weekly rate had been increased to 63 shillings (approximately $15.75 at par exchange). At this time it was agreed to add one shilling (approximately 25 cents) to the rate for every increase of 5 points in the index of the cost of living and a similar deduction for every decrease of 5 points. Permanent standards or "stop" rates were fixed at a point approximately 100 per cent above pre-war wages. Beyond this "stop" wages may not fall. The average "stop" is 53 shillings (approximately $13.25).

Under the sliding scale of wages, with increases of one shilling for each increase of 5 points in the cost of living index, wages were increased $2 a week above the 1919 rate. Since living costs have dropped, wage rates under the sliding scale have been decreased $2.25 a week. Generally speaking, therefore, wages are now about $15 a week, or 150 per cent above the pre-war level.

The total wage bill of the British railways in 1920 amounted to $798,106,000 as compared with $228,725,000 in 1913, or an increase of 250 per cent. Fifty-two cents of every dollar spent by the railroads in 1920 went for wages, as compared with 35 cents in 1913. The *Railway Mechanical Engineer* is indebted to the Bureau of Railway Economics for the data herewith presented.

Locomotive Orders

The Bahia Railways of Brazil have ordered 17 locomotives from the Baldwin Locomotive Works.

The Chicago, Rock Island & Pacific has ordered 14 Mikado type locomotives from the American Locomotive Company.

Delaware, Lackawanna & Western.—The Elvin Mechanical Stoker Company, New York, has been given an order by the Delaware, Lackawanna & Western for 49 Elvin mechanical stokers for installation on its Mikado type locomotives.

The Argentine State Railways have ordered 50 Mountain type and 25 Pacific type locomotives from the Baldwin Locomotive Works. These locomotives will all be of meter gage and will be equipped to use either wood or oil for fuel. The Mountain type locomotives are to be used for mixed service and will have 19 by 24-in. cylinders, 50-in. driving wheels and a total weight in working order of 170,000 lb. The Pacific type will be used for passenger service and will have 20 by 28-in. cylinder, 57-in. driving wheels and a total weight in working order of 173,000 lb. A sample Mountain type locomotive was built by the Baldwin Works about two months ago for the same roads.

Freight Car Orders

The Delaware, Lackawanna & Western has ordered 500 steel hopper cars of 50-ton capacity from the Cambria Steel Company; 500 from the American Car & Foundry Company and 500 from the Standard Steel Car Company.

The Baltimore & Ohio has ordered 500 steel hopper car bodies from the Cambria Steel Company, 500 box car bodies from the American Car & Foundry Company, 500 box and 500 steel hopper car bodies from the Standard Steel Car Company.

The Argentine State Railways, according to a press dispatch from Buenos Aires, dated October 18, have entered into a contract, subject to the approval of President Yrigoyen, with the Middletown Car Company for the delivery of 2,000 freight cars. Payment for the equipment is to be made in Argentine 6 per cent treasury notes maturing in five years.

The Chilean State Railways have ordered 100 general service gondola cars of 50-ton capacity, from the Pressed Steel Car Company; 200 box cars from the American Car & Foundry Company, and 100 flat cars from Belgian builders.

Welding Equipment Investment Nets 300 Per Cent

Practical application of the electric arc welding process was the subject of a paper read by E. Wanamaker, electrical engineer of the Rock Island, at a meeting of the Metropolitan Section of the American Welding Society, on September 20, at the Engineering Societies' Building, New York, N. Y. The paper dealt principally with the equipment, materials and skill required for successful welding. Mr. Wanamaker spoke particularly of the manner in which results are obtained on the Rock Island. A book of looseleaf specifications is sent to welders and welding foremen, which explains what can be welded, how the work can best be done, how to test the quality of a weld, etc., giving the welder sufficient information to work intelligently, provided he understands the fundamental principles, and keeping him up to date on all new practices. New sheets, superseding those in the book, are sent out as new methods are developed. Cleanliness and impressing the welder with his responsibility, said Mr. Wanamaker, are big factors in getting and maintaining good results.

It has been shown that an investment of $150,000 in welding equipment on the Rock Island has in a few years saved three times its cost.

After the practice of welding locomotive tires was established, no new tires were purchased for a period of three years, and the number now bought is only about one-third of the former average.

Operating Improvements on the Paris, Lyons & Mediterranean

The Paris, Lyons & Mediterranean is the longest privately owned railway in Europe, says the Railway Gazette (London), in presenting some interesting information concerning that road. At the end of last year it possessed a total stock of 4,662 locomotives (including those for narrow-gage lines) as compared with 3,571 at the beginning of 1914. Of these, 498 engines were American and 177 German, and during the year there were ordered 80 Pacifics, 120 Mikados and 50 ten-coupled locomotives. An interesting sidelight is thrown on the effects of the eight-hour day by the fact that it became necessary to open four new locomotive shops (a fifth will shortly be opened), and to enlarge six existing ones.

The company has submitted to the Ministry of Public Works a program for the electrification of some 1,800 miles of line, to be operated by hydro-electric power, which will largely be obtained from the Rhone. It is hoped to make a beginning on the Culoz-Modane line, which has very severe gradients and handles a heavy traffic. Like other French railways, the Paris, Lyons & Mediterranean has found it advantageous to make its own arrangements for the maritime transport of locomotive coal, and by the end of the current year it hopes to have received delivery of a new fleet of 14 vessels with an aggregate capacity of 100,000 tons, in addition to the seven already acquired.

Another of its activities has been the establishment of a refrigerator car and warehouse company, in co-operation with the Northern and Eastern Railways, which has leased the 550 refrigerator cars fitted up by the Paris, Lyons & Mediterranean for war service, as well as a number left behind by the American Army. Another American legacy, it may be recalled, was the train dispatching system. This has been experimented with between Dijon, Chalon-sur-Saone and Lyons, and the results have been so satisfactory that it is proposed to adopt the system on a much larger scale.

Training of Apprentices on the Victorian Railways.

The State Railways of Victoria, Australia, have in operation a comprehensive system of training apprentices, according to the Engineer (London). To quote: "Under these regulations it is possible to obtain a very good class of youths who, after a training in technical and practical work, are well prepared to become first class tradesmen, and eventually foremen. In some cases, when the ability of an apprentice is outstanding, he may become a member of the professional staff, and in course of time may be appointed head of his branch, as has occurred quite recently, when one, who joined the service as an apprentice 15 years ago, was appointed chief electrical engineer of the Victoria railways."

Bulletins are posted in various places announcing vacancies in the occupations and applicants apply in writing. When an apprentice is employed he is placed on probation for six months at the end of which time his fitness has been determined. The period of apprenticeship is five years, during which time the apprentice performs duties of the trade he is studying at one of the shops of the system. At the same time he must attend classes in designated trade schools where his tuition is paid. Apprentices are, as a general rule, paid 75 cents a day for the first year, 93 cents the second year, $1.31 the third year, $1.68 the fourth year and $2.25 the fifth year.

The school work required of all first year apprentices is the same, viz.: elementary science, arithmetic and geometry. In the second year the courses are mathematics, drawing and applied mechanics. Different courses are provided the third year for various crafts. Some of them are algebra, solid geometry, engineering, drawing, electricity, steam and design. Various prizes are offered by the company for good school work and of each third year class one student is chosen to study engineering. This student devotes the next two years, full time, to this work and receives $650 a year in lieu of wages besides his free tuition. If he completes the course satisfactorily he is given the position of engineering assistant at an entrance salary of $1,125 per annum.

Continuous Brakes in Germany

"It is well known," says the Railway Gazette (London), "that Germany is one of the countries where prior to the war the Westinghouse air-pressure brake was in general use. During the war conditions suffered a change, inasmuch as the Prussian authorities in their triumphant state of mind decided to introduce something different in detail from the Westinghouse air brake, in order to avoid foreign influence in this line of business and with a view to eliminating as far as possible foreign enterprise in the German territories. To find possible opportunities for alterations in the Westinghouse brake system the patents of this company were carefully studied, with the result that the fundamental idea in one of these patents—which happened to have just expired—was selected and developed into a so-called differential brake by introducing a very complicated new kind of valve.

"Letting alone for the present its technical features, it must be said that the innovation was effected by the Knorr Company in direct co-operation with the railway authorities themselves and their high officials; in fact, the name of the so-called new brake system includes the name of one of these officials. The Prussian government then decided to replace the Westinghouse brake by this newly-prepared system, pushing ahead the introduction of the so-called Kunze-Knorr brake with the greatest energy. Thus a fact was established to compel their enemies (after Germany emerged victorious from the war) to adopt the same kind of innovations that they themselves were going to introduce. The government went ahead so precipitately that as early as 1917 the means necessary to fit up the entire rolling-stock of their goods wagons (i. e. freight cars) with this new brake were afforded by the Prussian Diet. The execution of the program was taken up without delay. As a second step the Prussian government went on to eliminate Westinghouse, assigning to the Knorr company practically the whole of the repairs on cars equipped with the Westinghouse brake proper, the brake parts being provided from the stores of the Knorr company as 'Knorr-West brake parts,' as they were called, and at prices which are fixed in an official catalogue.

"Both England and America think that these peculiar ways are neither in accordance with the aims of the International Commission, which in itself has been shunned by the Prussian authorities, nor with certain stipulations of the Peace Treaty. It would be interesting if the German Government would explain why, in spite of its heavy financial obligations, it is spending such enormous sums for new equipment, which expenditure could not be afforded even by the victorious parties for similar purposes."

The Spanish Railway Problem

The railway problem in Spain is somewhat similar to that in this and other countries, according to Commerce Reports. Operating costs have risen to the point where freight and passenger rates must be increased or some corresponding form of relief discovered if the roads are to continue to operate and escape bankruptcy. The public is not in favor of an increase in rates.

Nor are the railways giving satisfactory service. They are built on three different gages, approximately 5 ft. 6 in., 4 ft. 8½ in., and 3 ft. 4 in., respectively, and as they all radiate from Madrid, they do not always meet the economic needs of the country.

Among other efforts the government is making to meet the present situation, they have decided to encourage the construction of locomotives and cars in Spain, and have arranged that when bids are called, the business shall be awarded to manufacturers in Spain, provided their price does not exceed foreign offers by more than 10 per cent. In addition to this preference they have increased the duty on imported locomotives and cars, and Commercial Attaché Cunningham, of Madrid, reports that further increases are to be expected. Moreover, Spanish industrial plants, on complying with certain formalities, are allowed a reduction in the import duties charged on foreign manufactured materials needed in the construction of locomotives and railway cars.

As a result of the government's activities, the production in Spain of railway equipment of the class mentioned has been stimulated, and Commercial Attaché Cunningham reports that in the first six months of this year orders have been placed for the construction of 5,000 European pattern railway, freight, passenger, and baggage cars with 16 different Spanish plants in different parts of the country.

Correspondingly, the Maquinista Terrestre y Maritima has received an order for 50 locomotives, of which five have been delivered, and as these are larger and more powerful than other engines previously in operation, the better service resulting is adding to the prestige of these builders and to the disadvantage of the German, Belgian, French, Italian and British manufacturers who have previously supplied most of the locomotives operated in Spain.

Other companies plan to build locomotives in Spain, and, in addition to the inducement mentioned, there are other ways to show them preference. The Sociedad Espanola de Construcciones Babcock and Wilcox has been extended an exemption from the payment of imports and stamp taxes covering an issue of 39,200 shares of 500 pesetas (1 peseta = \$.193 at par) each, and also a 60 per cent reduction during five years from the amounts that would ordinarily be due under the utilities tax. These special benefits are understood to have been accorded to assist this company in the production of locomotives and parts and similar products. Recently the Spanish government established an industrial bank with a capital of 150,000,000 pesetas, which is reserved for loans to purely Spanish enterprises.

Meetings and Conventions

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Next annual convention June 14 to 21, 1922, Atlantic City, N. J.

Division V—Equipment Painting Division.—V. R. Hawthorne, Chicago.

American Railway Association, Division VI.—Purchases and Stores.—J. P. Murphy, N. C. C., Collinwood, Ohio.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamlin Ave., Chicago.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Society for Steel Treating.—W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

Canadian Railway Club.—W. A. Booth, 131 Charron St., Montreal, Que. Regular meeting 2d Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Meeting second Monday in month, except June, July and August. New Morrison Hotel, Chicago, Ill.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Annual dinner Thursday evening, November 10, at 7:30 p. m. Hon. Charles F. Moore, the Virginia judge, will be toastmaster. A prominent speaker will be present. Dancing and other entertainments.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Next meeting November 8, Hotel Sinton, Cincinnati. Annual banquet and election of officers. Musical entertainment.

Dixie Air Brake Club.—E. F. O'Connor, 10 West Grace St., Richmond, Va.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 715 Clarke Ave., Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn.

Master Boilermakers Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y. Next annual convention Hotel Sherman, Chicago, May 23 to 26, 1922.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting November 8. Paper on "Activities of the American Railway Association," will be presented by Mr. Aishton, president, American Railway Association.

New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Next meeting November 18. Paper to be presented on "Passing the Buck—Not the Dividend," by Howard Elliott, American Sugar Refining Company.

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Next meeting November 10, at Hotel Oakland, Oakland, Cal. Paper on "Supervision of Transportation" will be presented by J. H. Leary, superintendent, Western Pacific, and T. F. Allen, supervisor of transportation, Northwestern Pacific. General discussion (invited) by supervisors of transportation, superintendents and trainmasters.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meetings fourth Thursday in each month, except June, July and August, at Americus Club House, Pittsburgh, Pa.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Meeting second Friday of each month, except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Regular meetings third Monday in each month, except June, July and August.

PERSONAL MENTION

GENERAL

J. C. Nolan, superintendent of the Texas division of the Gulf Coast Lines, with headquarters at Kingsville, Tex., has been appointed mechanical superintendent, with the same headquarters, succeeding J. L. Lavallee, resigned. J. E. Callahan, superintendent of the Louisiana division, with headquarters at De Quincy, La., has succeeded Mr. Nolan as superintendent of the Texas division, and G. C. Kennedy has succeeded Mr. Callahan as superintendent of the Louisiana division.

F. S. Wilcoxen has been appointed fuel supervisor of the Chicago Great Western, with headquarters at Chicago.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

Lee Pearson has been appointed road foreman of engines of the Atchison, Topeka & Santa Fe at Needles, Cal.

SHOP AND ENGINEHOUSE

E. P. Eich has been appointed day roundhouse foreman and John Wren night roundhouse foreman of the Chicago, Rock Island & Pacific at Kansas City, Kans.

Harvey Grange has been appointed general foreman of the Chicago & Northwestern, with headquarters at Clinton, Iowa.

H. W. Sasser has been appointed shop superintendent of the Erie at Galion, Ohio, succeeding G. T. Depue.

W. Wilcox has been appointed roundhouse foreman of the Illinois Central at Jackson, Tenn., succeeding C. B. Thompson, transferred to Birmingham, Ala.

PURCHASING AND STORES

F. J. Talbot has been appointed superintendent of stores of the New York and Hornell regions of the Erie with headquarters at Hornell, N. Y., and J. H. Sweeney has been appointed to a similar position for the Ohio and Chicago regions, with headquarters at Meadville, Pa.

J. D. McCarthy, who has been appointed purchasing agent of the Minneapolis & St. Louis, with headquarters at Minneapolis, Minn., succeeding W. E. Manchester, was born at Chicago, Ill., on August 26, 1881. He entered railroad service in 1899 with the Chicago Great Western, and served successively until 1904, as roadmaster's clerk, chief clerk to the division engineer and division storekeeper. From 1904 to 1906 he served in the accounting department of the Chicago, Rock Island & Pacific. In 1906 Mr. McCarthy entered the service of the Chicago & North Western and through various promotions became assistant purchasing agent of that company. He was serving in this capacity at the time of his recent appointment.

J. D. McCarthy

A. J. Mello has been appointed superintendent of commissary stores of the Southern Pacific, with headquarters at San Francisco, Cal.

A. Singleton has been appointed purchasing agent and general storekeeper of the Hocking Valley, with headquarters at Columbus, Ohio, succeeding J. R. Mueller, purchasing agent, and Leon Stiers, general storekeeper, assigned to other duties.

SUPPLY TRADE NOTES

H. E. Billau, a field representative of the Sherwin-Williams Company for the past 35 years, died at Fremont, Ohio, on September 19, 1921.

George A. Barden has been appointed railway sales representative with headquarters at 4631 York road, Philadelphia, Pa., of the Lowe Brothers Company, Dayton, Ohio.

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., will establish a branch in charge of V. D. Clark, at 316 Thirteenth street, Huntington, W. Va.

James A. Slater, manager of sales of the National Malleable Castings Company, at Chicago, has been appointed assistant sales manager with headquarters at the company's general offices in Cleveland, Ohio, succeeding J. H. Redhead.

Morris B. Brewster has formed a corporation under the name of Morris B. Brewster, Inc., with headquarters at 332 South Michigan boulevard, Chicago, to handle metallic packing, mechanical devices, such as Edson diaphragm pumps and similar articles. Associated with Mr. Brewster in the new company are W. B. Leach, J. G. Platt and F. M. Weymouth of Boston.

A. Clarke Moore, formerly assistant to the president of the Globe Seamless Tube Company, has been appointed vice-president of the Chicago Railway Equipment Company, succeeding the late C. Haines Williams, deceased. Mr. Moore has been actively engaged in the railway supply business for the past 22 years. In July, 1899, he entered the service of the Safety Car Heating & Lighting Company, which company he served until November, 1919, with the exception of a year and one-half in 1906 and 1907, when he was with the Western Steel Car & Foundry Company and McCord & Company. During this time he filled various positions, serving for the last six years as vice-president, and for the two years prior to that time as general manager. During the war Mr Moore was commissioned a major in the Air Service department, with headquarters at New York, having charge of the production of air craft in the eastern territory. In November, 1919, he became associated with the Globe Seamless Steel Tube Company of Chicago as assistant to the president, from which position he resigned in August, 1921. As vice-president of the Chicago Railway Equipment Company, Mr. Moore will have general supervision of the manufacturing and selling departments.


A. C. Moore

The Toronto, Ontario, office of the Independent Pneumatic Tool Company, Chicago, has been removed from 32 Front street West, to larger quarters at 163 Dufferin street, Toronto. This office will remain in charge of William McCrae.

The Superior Supply Company, Chicago, has been appointed the direct factory representative of the Novo Engine Company, Lansing, Mich., and will handle the sale of the Novo line of portable power driven outfits, including pumps, hoists, compressors, saw rigs, etc.

G. R Watson, formerly electrical supervisor for the Pullman Company at Chicago and later representative of the Crouse-Hines Company at Cincinnati, Ohio, has been appointed general sales manager of the Wadsworth Electric Manufacturing Company, Inc., with headquarters at Covington, Ky.

Andrew G. Young, traffic manager of the American Sheet & Tin Plate Company, died at Cleveland, Ohio, on September 29. Prior to his appointment, 20 years ago, to the position which he held at the time of his death, Mr. Young was serving as general freight agent on the Lake Erie & Western.

C. J. Burkholder, who has been serving the Franklin Railway Supply Company, New York, as special engineer in the western territory, is now supervising service for the same company on all railroads. A sketch of Mr. Burkholder's career was published in the August issue of the *Railway Mechanical Engineer.*

Sidney G. Down has been appointed to the newly created office of general sales manager of the Westinghouse Air Brake Company, with headquarters at Wilmerding, Pa. He was formerly Pacific District Manager of the Westinghouse Air Brake interests and president of the Westinghouse Pacific Coast Brake Company. Mr. Down served as general air brake inspector and instructor on the Michigan Central until 1901, and then joined the Westinghouse Air Brake organization. He was for several years instructor on the company's instruction car and later was appointed mechanical expert with headquarters in Chicago. In 1910 he was appointed district engineer and transferred to San Francisco and shortly afterward he was appointed Pacific district manager. He was largely responsible for the organization of the Westinghouse Pacific Coast Brake Company in California, and when it was formed, became vice-president and later president of that company. Two years ago he made an extensive tour of the Far East and established various commercial activities which have resulted in an increased business for the Air Brake Company from the Orient.


S. G. Down

T. N. Gilmore, who for the past sixteen years has been associated with Westinghouse, Church, Kerr & Co., engineers and contractors, has opened offices as a consulting engineer at 136 Liberty street, New York. Mr. Gilmore was in charge of railroad shop and engine terminal work for Westinghouse, Church, Kerr & Co., and was for several years a director and vice-president and chief engineer of the company in charge of all engineering and construction. Mr. Gilmore received his early training in steam railroad work. Prior to the World's Fair at St. Louis in 1904, he went with the St. Louis Terminal, where he was in charge of the mechanical and car departments and in addition planned the power houses, locomotive shops and engine terminal facilities constructed to handle the traffic for the fair. Mr. Gilmore is a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers and the Structural Engineers Association of Illinois.


T. N. Gilmore

H. O. Davidson has been appointed to take entire charge of the Prudential Sectional Building Department of the Blaw-

Knox Company, with headquarters at Baltimore, Md., where he will also serve as general manager of the C. D. Pruden plant, of the Blaw-Knox Company. At the time of his appointment Mr. Davidson was general manager of the Hydraulic Steelcraft Company.

O. B. Frink, assistant principal engineer of the Hall Switch & Signal Company, Garwood, N. J., has been appointed representative of the Waterbury Battery Company, Waterbury, Conn., with office at 30 Church street, New York City, and S. J. Hough, field service engineer at New York, of the Waterbury Battery Company, has been appointed western representative with office at 1361 Peoples Gas building, Chicago, Ill.

Charles B. Seger, president of the United States Rubber Company, New York, has been elected also chairman of the board, succeeding as chairman Col. Samuel P. Colt, deceased. Mr. Seger was born on August 29, 1867, at New Orleans, La., and was for many years in railway service, having begun work as an office boy with Morgan's Louisiana & Texas Railroad & Steamship Company, now a part of the Southern Pacific. He subsequenlty served as a clerk until 1887, when he was appointed steamship auditor. He was then auditor and later clerk to the chief auditor until 1893, when he was appointed auditor and secretary of the Galveston, Harrisburg & San Antonio, the Texas & New Orleans and the Direct Navigation Company. In January, 1900, he was appointed also auditor and secretary of the Galveston, Houston & Northern. On November 1, 1904, he was appointed auditor of the Southern Pacific—Pacific system, with office at San Francisco, Cal., and six years later became general auditor of the Southern Pacific-Union Pacific systems, later serving as deputy controller until the separation by the courts of the Southern and Union Pacific systems in 1913, when Mr. Seger became vice-president and controller of the Union Pacific and from March to December, 1918, served as acting chairman of the executive committee and as president. Since January 1, 1919, he has been president of the United States Rubber Company and now becomes also chairman of the board, as above noted.


C. B. Seger

T. E. Cocker has been appointed district manager of the Chain Belt Company, in the Buffalo territory, with headquarters at Buffalo, N. Y. Mr. Cocker is a graduate of the Rensselaer Polytechnic Institute, class of 1907, civil engineering. From 1907 to 1917 he served in the engineering department of the New York Central at Buffalo, holding the position of assistant engineer at the time he left the railroad. For the past five years he has been handling elevating and conveying equipment.

The Central Steel Company, the National Pressed Steel Company and the Massillon Rolling Mill Company, all of Massillon, Ohio, have been brought together in a merger just completed. The new corporation takes the name of the Central Steel Company and the following officers have been elected: Chairman of the board of directors and president, R. E. Bebb; first vice-president, F. J. Griffiths; second vice-president, C. C. Chase; third vice-president, H. M. Naugle; secretary and treasurer, C. E. Stuart. The reorganized company has complete modern equipment and facilities for producing all kinds of commercial alloy steels, hot and cold rolled sheets, hot rolled strip steel and light structural steel.

J. H. Redhead, assistant manager of sales of the National Malleable Castings Company, has resigned to become manager of the Reliance Company, Cleveland, Ohio, which firm has recently been organized by the Reliance Trust Company in conjunction with its affiliated companies, the Reliance Savings and Loan Company and the Reliance Securities Company. These companies are engaged in various banking and investment activities. Mr. Redhead was born in Cleveland in 1880 and was graduated from Central High School of that city in 1899. He began his career as an office boy with the National Malleable Castings Company and worked through various branches of the accounting department until 15 years ago when he entered the sales department. He was lately appointed assistant manager of that department. For several years Mr. Redhead has been in charge of the advertising carried on by the American Malleable Castings Association.

F. H. Sauter, formerly associate editor of the Locomotive Dictionary, has accepted a position with Gibbs & Hill, consulting engineers, Pennsylvania Station, New York City. His work with this firm will have to do with the development of railway electrification. Mr. Sauter was born in Schenectady, N. Y., February 1, 1877, and was educated in the public schools of Schenectady. In 1894, he entered the General Electric Company's factory and completed a mechanical engineering course under private instruction during the factory employment period. In January, 1900, he entered the General Electric Company's drafting department and in 1903 he worked with the Schenectady Railway Company as assistant master mechanic. In the fall of 1904, he served with the Peckham Manufacturing Company, Princeton, N. Y., as electric truck designer. In 1905, he entered the services of the American Locomotive Company, Schenectady, N. Y., and while with this company he held positions as draftsman and designer of steam locomotives, electric trucks, and electric locomotives, and as electric locomotive and truck estimating engineer. In December, 1917, he entered the employ of the Simmons-Boardman Publishing Company as associate editor of the Locomotive Dictionary. He went to the Crown, Cork & Seal Company, Baltimore, in May, 1918, and in July of that year was made supervisor of Trade Machinery and in April, 1920, assistant manager of the machine erecting department. The duties of this position included adjustment of machine complaints and personal visitation of the trade in the entire territory east of the Mississippi and some of the Western states.


F. H. Sauter

George R. Henderson, formerly consulting engineer of the Baldwin Locomotive Works, died on October 19, at Media, Pa. He was born on January 14, 1861, at Philadelphia, Pa., and graduated from Lauderback Academy, Philadelphia, in 1876. Two years later he began railway work serving consecutively to 1887, as apprentice, draftsman and assistant chief draftsman of the Pennsylvania Railroad. He was then to March, 1899, with the Norfolk & Western as assistant superintendent of the Roanoke shop and mechanical engineer. From March to July, 1899, he was with the Schenectady Locomotive Works, and from July of that year to June, 1901, served as assistant superintendent of motive power and machinery of the Chicago & North Western. He was then assistant superintendent of machinery and superintendent of motive power of the Atchison, Topeka & Santa Fe until August, 1903. The following year he became a consulting mechanical engineer at New York and in 1910 went to Brazil, serving for two years on the railways of Brazil. He then returned to the United States to become consulting engineer of the Baldwin Locomotive Works. During the war Mr. Henderson was consulting engineer to the Federal Fuel Administration in the Philadelphia district. He was well known as the author of books on locomotive operation and was a frequent contributor to the railway technical press.

TRADE PUBLICATIONS

Reclaiming Tools.—Illustrations, prices and instructions for figuring prices are contained in a 16-page catalogue which the Master Tool Company, Cleveland, Ohio, has recently issued presenting its line of reclaiming portable pneumatic tools.

Reclaiming Portable Pneumatic Tools.—The Master Tool Company, Cleveland, Ohio, has recently issued a 16-page illustrated catalogue and price list presenting its line of reclaiming portable pneumatic tools, their parts, and special tools, also instructions for figuring prices.

Tube Welding Machinery and Fabricating Equipment.—An illustrated bulletin listing a complete line of machinery for producing welded tubing from commercial steel sheets, or rolled strip stock, and briefly describing the procedure has been recently issued by the Davis-Bournonville Company, Jersey City, N. J.

Weight Cards.—The American Sheet & Tin Plate Company, Pittsburgh, Pa., has issued a new and revised set of weight cards covering black sheets, galvanized sheets, and formed products. These cards are 14 in. by 20 in. in size, are clearly printed and are of particular value to all buyers and users of sheet steel.

Metal Spraying.—The Schoop Metal Spraying Process, a means by which metallic coatings of any kind may be sprayed onto any surface, is fully described and illustrated in an interesting booklet of 16 pages, recently issued by the Metals Coating Company of America, Philadelphia, Pa.

Belting.—A summary of efficiency tests on various types of belting and two interesting charts showing slack of belt at point of slip-off and comparative efficiencies of various types of belts, as well as a price list of Lion Paw belting, are included in a 10-page booklet entitled "Cutting the Unreckoned Costs," recently issued by R. D. Skinner & Co., New York.

Spray-Painting.—The De Vilbiss Manufacturing Company, Toledo, Ohio, has recently issued an interesting folder describing its portable spray-painting system for spray-painting houses, building interiors and exteriors, railway equipment, bridges, ships and all kinds of large or stationary work. Clear-cut illustrations of the various outfits are shown, as well as photographs illustrating the performance and adaptability of the De Vilbiss equipment.

Power Pipe Machines.—Valuable data and information regarding the care and use of dies for threading pipe, as well as a very interesting illustrated story of business and pleasure in which the pipe machine is compared to the automobile, are presented in a 54-page booklet entitled "Don't Let it Happen to You," issued by the Williams Tool Corporation, Erie, Pa. This booklet is offered in an endeavor to educate and instruct operators of power pipe machines for better threads and greater production.

High-speed Steel.—The Vanadium Alloys Steel Company, Latrobe, Pa., has recently issued an interesting four-page folder illustrating most forcibly the heavy cuts which may be taken with Red Cut Superior High-speed Steel. The inside pages of the folder are devoted to a large scale photograph showing the tool post, roughing tool and chip taken in a recent test of the new 60-in. Houston, Stanwood & Gamble engine lathe. In this test a 16-in. alloy steel forging was reduced to 12¼ in. in diameter, using a ¼-in. feed at the rate of 15 ft. per min.

Belt Lacing.—The Flexible Steel Lacing Company, Chicago, has endeavored to eliminate the exhaustive technical formulas common to belting problems, and to simplify old practices with proven modern methods by incorporating the most important phases of practical belting practices in separate chapters in a 64-page booklet, entitled "Short Cuts to Power Transmission." The data given, while simple, is accurate and reliable and will be of value to both the engineer and to the man who includes an occasional engineering problem with his other work.

Zin-Ho Portable Air Compressors.—Under this title The Mundie Manufacturing Company, Peru, Ill., has issued a 16-page booklet describing its line of portable air compressors, either gasoline engine or electric motor driven, ranging in capacity from eight cubic feet of free air per minute to 230 cubic feet of free air per minute. The outfits are mounted on channel steel frames with steel wheels and all of the units may be supplied with flange wheels for railroad use, for use in car repair yards, cleaning and painting bridges, drilling rock for the installation of telegraph poles, etc.

The Tank Car.—An unusually important catalog which will be of interest to owners and users of tank cars has been issued by the Pennsylvania Tank Line, Sharon, Pa. In addition to illustrations and specifications of cars as made by the Pennsylvania Tank Car Company, the catalogue contains considerable general information, such as the A. R. A. standards and specifications for tank cars, interchange rules, mileage, demurrage, car accounting records, regulations for the transportation of inflammable and other dangerous liquids, safety appliance standard, and gage tables for contents of tank cars.

Chucks.—"Chucks and Their Uses" is the title of a very interesting and instructive booklet issued by the Skinner Chuck Company, New Britain, Conn. The booklet begins with a history of chucks and the story of their development. Then the various types of chucks and their uses are taken up, each type being explained separately and in detail. Suggestions are offered regarding the proper way to fit a chuck to a lathe and the care of the chuck. An interesting feature of the booklet is a number of succinct and homely "don'ts" that should be of interest to every practical user of chucks.

Railway Cars for Export and Domestic Use.—A very complete catalogue of railway cars of both export and domestic types has been issued by the joint export sales offices of the Magor Car Corporation of New York and the National Steel Car Corporation, Ltd., of Hamilton, Ontario, Canada. The book is well illustrated and metric equivalents of all dimensions are given. A private cable code is also included for the convenience of customers. It is planned to issue other editions later in Spanish, Portuguese and French. This catalog contains 155 pages, 9 in. by 13 in., and is well printed and bound.

Thermalloy High Temperature Castings.—Under this title the Electro Alloys Company, Cleveland, Ohio, has issued a circular describing the properties and uses of Thermalloy, a high chromium alloy which remains unchanged under drastic thermal conditions. Its ability to withstand high temperatures for long periods with freedom from oxidation, bending, warping and cracking on alternate heating and cooling and the ability to cast it in thin sections makes it particularly adaptable for carbonizing and annealing boxes, lead, cyanide and salt pots, pyrometer protection tubes, automatic stoker parts and other objects subjected to high temperature. The material is also readily formed and is machined without difficulty.

Roundhouse Repair Facilities.—The current issue (No. 29) of the Progress Reporter, a booklet issued by the Niles-Bement-Pond Company, New York, is the first of a series of six special railroad numbers to be published by the company at intervals of a few months. It contains interesting and valuable data regarding engine terminals and terminal layouts; also carefully prepared machine tool lists, with recommendations for the arrangement of such tools and facilities. Several roundhouse and repair shop layouts are included, together with a number of clear-cut illustrations showing machine tool equipment in actual operation in locomotive terminals throughout the country, all of which add to the attractiveness of this issue. The five succeeding numbers will cover the following: Smith, Hammer Shop and Foundry; Running Gear Repair; Boiler and Tank Shop; Miscellaneous Machines, Repair Department, and Car Repair Department.

Superheaters for Small Locomotives.—The advantages derived from the use of superheated steam are recognized so generally by railroad motive power officers that it would seem hardly necessary again to call attention to them. Gains equivalent to those obtained from the application of superheaters to large railroad locomotives are being realized on small industrial locomotives of 40 ton weight or under such as are used around industrial plants, in quarries, gravel pits, mines, logging operations, construction work, etc., but as the owners of locomotives of these types are usually not so familiar with the details of locomotive design as are railroad motive power officers, superheaters have not been so generally used on their motive power. Bulletin No. 9 of the Superheater Company shows what has already been accomplished in the industrial field and will be of interest to anyone who is responsible for the purchase or operation of small industrial locomotives.

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Volume 95 December, 1921 No. 12

CONTENTS

EDITORIAL:
- The Planer Type Milling Machine 733
- Production Machine Forging 733
- Specialized Training vs. Apprenticeship 734
- Air Area Through Grates and Ash Pans 734
- Length of Tubes and Combustion Chambers 734
- Aluminum Parts for Locomotives 734
- Save Labor in Refitting Hose 735
- Don't Neglect the Power House 735
- Comprehensive Electrification Again Proposed 735

COMMUNICATIONS:
- Car Wheel Grinding Data Desired 736
- Comment on the Purchase of Machine Tools 736
- New Books 736

GENERAL:
- 2-8-2 Type Locomotives for the Nickel Plate 737
- Causes of the Present Bad Order Situation 738
- Plan for Electrifying Sections of Eleven Railroads 739
- Method of Laying Out Walschaert Valve Gear 744
- Operating and Maintaining Oil Burning Locomotives 747
- Locomotive Weighing Plant of Large Capacity 749

CAR DEPARTMENT:
- Repairing Steel Cars in a Remodeled Roundhouse 751
- Supplying Additional Information on Billing Repair Card 753
- Suggestions for Passenger Car Design 754

CAR DEPARTMENT—Continued:
- Illinois Central Steel Suburban Coaches 755
- The Requirements for a Modern Car Repair Shop 759
- Handling Milk in Specially Constructed Tank Cars 763
- British Views on Fuel-Oil Installations 764

SHOP PRACTICE:
- Two Boiler Shop Tools 765
- Planer Type Milling Machine Makes Record 766
- Six-Roll Superheater Flue Expander 768
- Machine Forging at Elizabethport 769
- Standards of Railroad Shop Welding Practice 772
- Characteristic Heat Treatment Curves 775
- Hydraulic Rod Bushing Press 776

NEW DEVICES:
- New Planer Designed for Maximum Service 777
- Welding Sets for Medium and Heavy Duty 779
- One Hundred-Ton Locomotive Shop Truck 780
- Hose Dismantling and Assembling Machine 780
- Propeller-Type Blower of Novel Design 782
- Overhead Handling System Lowers Shop Costs 782
- New Type of Spiral Boiler Tubes Developed in Sweden 783
- Drop Forged Cutters for Wheel Lathes 784
- Hydraulic Driving Box and Rod Bushing Press 784
- Recent Improvements in Adjustable Crosshead 785
- Eight-Inch Electric Bench Grinder 785

GENERAL NEWS 786

The Planer Type Milling Machine

An article in this issue describing the machine operations performed on a four-head, planer type milling machine, recently installed in the Beech Grove shops of the Big Four, will be read with interest by railroad machine shop men. While this type of machine has demonstrated its value before in railroad shops, it has by no means come into the general use that would seem warranted by the production secured. For the quantity machining of certain locomotive and car parts, no more productive tool can be used. The article in question shows how locomotive driving boxes and crossheads are machined on this miller in one-third to one-quarter of the time formerly required on a planer. This does not mean that the milling machine is always more effective than the planer because, for many operations, the planer is the more adaptable tool. Also, when single parts are to be machined, the time required to set up and perform the operation on a planer is less than when setting up the work on a milling machine and getting milling cutters of the required shape and size to perform the work. For the quantity production of many duplicate parts, however, the milling machine cannot be equaled.

Three important advantages of the planer type milling machine are the large proportion of total power used in removing metal, a cutting operation which is continuous, and the reduction in time required for tool setting and grinding. It is obvious that with a considerable number of cutting edges working at the same time the milling cutter can remove metal much faster than any tool having but a single cutting edge and experience has demonstrated that milling machine work possesses the advantages of both accuracy and high production. There seems little question that one way to increase the productive capacity of many medium and large sized railroad shops would be by the more general use of planer type milling machines to perform duplicate machine operations on locomotive and car parts.

Production Machine Forging

In most railroad repair shops the blacksmith departments occupy a less important position than formerly, due to the greatly increased use of the autogenous cutting and welding process. In one line of endeavor, however, the blacksmith shop is more than holding its own and that is in the quantity production of locomotive and car parts, made on forging machines. In fact, the general impression gained by visiting a modern railroad blacksmith shop is that the most efficient production methods have been developed in machine forging work. Bolts are being made in great numbers and all sizes. Truck cross-ties, draft sills, reinforcement channels, drawbar yokes, air brake levers and rods, and literally hundreds of small parts for use on locomotives and cars, are being produced in quantity by efficient forging machines at a reasonable cost. The quality of this work is excellent and its cost compares favorably with that of other methods of manufacture. Elsewhere in this issue is an article on machine forging practice at the Elizabethport shops of the Central of New Jersey in which four typical forging machine operations are described in detail, showing the dies used and the sequence of operations. This article will be of interest to railroad men employed in blacksmith shops and others concerned in the production secured with forging machines. Oftentimes great mechanical ingenuity and knowledge of the flow of metal under pressure is displayed in the design of forging machine dies and railroad men deserve much credit for the present development of this art. More or less complicated parts are made at a single blow and, taken all together, almost no part of railroad blacksmith shop work exceeds, either in interest or value, that done on forging machines.

Specialized Training vs. Apprenticeship

In discussing apprenticeship, a shop superintendent stated recently that he was disappointed because so few satisfactory apprentices could be induced to enter the course. The majority of applicants were foreigners, who proved very slow to learn and would have been rejected except for the fact that competent mechanics were badly needed and it was desirable to train as many as possible. This is not an unusual condition. It will be remembered that a survey made by the Railroad Administration showed a very low ratio of apprentices to mechanics throughout the country. There is still a demand for men with all-round training and always will be, for it is from this class that foremen should be recruited. On the other hand, if the apprentice course cannot supply the required number of skilled mechanics some other means, such as part-time instruction, should be provided for training promising employees in order to develop efficient workers in each special field. Would not the benefits obtained in increased output and the flexibility of the organization justify the small expenditure necessary to carry out such a plan?

Air Area Through Grates and Ash Pans

It is unfortunately a very common characteristic of human nature to place small value upon, and to give scant consideration to, those things that are common and cost but little money or effort to obtain, while those which are expensive are highly prized. With the steadily mounting costs of fuel there is an increasing attention being given to the subject of economies in its use and much is said and written on fuel conservation. In considering the design of locomotives for economical operation, careful consideration is given to the grate area, the firebox, the arrangement of heating surfaces and the probable savings which might result from the adoption of various devices. These points are of prime importance and are worthy of even more consideration than they oftentimes receive. However, the fact that coal cannot be burned without an adequate supply of oxygen must not be overlooked. Although it is not necessary to purchase air, provision must be made for its access to the fuel bed. This means that there must be openings of a proper size through the grates and through the ash pan.

As an illustration of the air requirements, consider a modern Mikado freight locomotive having 70 sq. ft. of grate area in which the attempt is made to burn coal of 12,000 B. t. u. heating capacity at the rate of 120 lb. per sq. ft. of grate per hour. This is equivalent to 2 1/3 lb. of coal per sec. and as it is necessary to furnish approximately one pound of air for every 1,000 B. t. u. in a pound of coal, this means an air supply of 28 lb., or 368 cu. ft. per sec. at a temperature of 62 deg. F. While it may be possible to draw sufficient air into the firebox at moderate rates of combustion, at the higher rates the supply is frequently decidedly inadequate and this becomes the controlling factor when forcing locomotives to their maximum capacity. The design and proportions of grates and ash pans are too frequently left to any draftsman who can make slight changes in dimensions of older drawings to fit such details to the size of the firebox and provide the necessary clearances. Instead of considering this as a subject of minor importance and entrusting it to a man who knows only partially what he is doing, the air inlet proportions should have the consideration of the best informed engineer.

Length of Tubes and Combustion Chambers

Experimental data have conclusively shown that the gain in evaporation obtained by increasing the length of the tubes beyond a certain amount is by no means proportional to the increase in the amount of heating surface. For example, an increase in the length of 2¼-in. tubes from 20 ft. to 25 ft. adds only about 5 per cent to their evaporative capacity despite the fact that their heating surface is increased 25 per cent. For additional increase in length the gain in evaporative capacity is even proportionately less. In a boiler having 2¼-in. tubes, 25 ft. long, the evaporation taking place from the last 2 ft. next to the smokebox is only about 10 per cent as much as from the first 2 ft. next to the firebox. For the best results the length of the tubes should not be more than 120 times the inside diameter, or about 20 ft. for tubes of 2¼ in. outside diameter. With tubes of this length there will be sufficient space for an ample combustion chamber in all boilers of long wheel-base locomotives. The value of the more complete combustion and the better mingling of the gases before they enter the tubes, and also the high value of the evaporative surfaces of a combustion chamber which are obtained from the use of this valuable extension of the firebox volume are quite generally recognized today.

These points were unfortunately not as well known a few years ago and as a result many comparatively modern locomotives have boilers in which the tubes are longer than they should be. In such cases when extensive overhauling, including considerable boiler work, becomes necessary, it would be wise to consider whether the expense involved in shortening the tubes and adding to the length of the combustion chamber would not so increase the steaming capacity and reduce the fuel consumption as to render probable a large return on the money expended in making the changes.

Aluminum Parts for Locomotives

Ordinary aluminum has been used very little in engineering work. The lightness of the metal is a great advantage for certain purposes, but this is outweighed by the low strength and small ductility. Aluminum weighs about one-third as much as steel and has about one-third the strength of mild steel so that parts designed to resist equal tensile stresses would weigh about the same whether made of aluminum or steel. During the war investigators in England devoted considerable attention to experiments with aluminum alloys. Some remarkable results were achieved, the details of which have recently been made public. It was found that the characteristics of aluminum are affected to a marked degree by the addition of small amounts of other metals. By changing the amounts of alloying elements added, material has been produced that is little heavier than aluminum and as strong as mild steel and with equal fatigue resisting properties.

One of the aluminum alloys which is suitable for use at ordinary temperatures consists of aluminum with about 13 per cent of zinc and 2½ to 3 per cent of copper. The tensile strength of this alloy is 44,000 lb., the elongation 4 per cent in two inches and the density 3.0. The aluminum-zinc alloys show a considerable decrease in strength as temperature increases, but special compositions have been developed to overcome this tendency. An alloy of aluminum with 4 per cent of copper, 2 per cent of nickel and 1½ per cent of magnesium shows a tensile strength of 52,000 lb. per square inch at normal temperature, which decreases only to 44,000 lb. at 250 deg. C. (482 deg. F.). This material can be forged or rolled.

The work completed up to this time probably marks only the beginning of the development of aluminum alloys, but even so it may open new possibilities in the design of locomotives; for example, if the weight of crossheads and pistons could be reduced one-third by the use of these metals, the problem of counterbalancing would no longer be so troublesome. Relative cost is, of course, a factor that must be considered and parts made of aluminum alloys, in spite of their light weight, would be several times as expensive as steel. However, where the weights of the reciprocating parts are a serious factor, the application of aluminum alloys may prove to be justified.

Save Labor in Refitting Hose

One of the most familiar operations in the air brake departments, especially of car repair shops, is the dismantling and assembling of air brake hose. On the locomotive side, signal and steam heat hose also have to be refitted as fast as the hose become worn out or defective. At certain small points practically all dismantling and refitting is done by hand and, where the number of hose involved is small, this method is probably entirely satisfactory. At other points, home-made devices of various sorts have been devised and used with more or less success. At large shops, however, where the number of hose to be dismantled and refitted often amounts to several hundred or even thousands each month, it is obviously poor economy to do the work by hand or with inefficient, home-made devices.

For the purpose of dismantling and assembling air, signal and steam heat hose, a special machine has been developed with a view to combining the desirable features of ease of operation and high production. It is said that with this machine one operator can cut the clamp bolts on 140 hose in 20 min., dismantle these hose in 40 min., and reassemble new hose complete, applying clamp bolts and nuts at the rate of 30 hose ready for service, in 60 min. With such a production the machine should have no difficulty in paying a considerable return above interest and depreciation charges and prove a profitable investment in any railroad shop faced with the problem of dismantling and assembling large numbers of air, signal and steam heat hose.

Don't Neglect the Power House

The power house is generally recognized as a vital part of every shop plant. Practically every important operation is dependent on this source of energy. Placed out of the way, often some distance from other shop buildings, the power house is likely to receive only casual attention from the shop executive so long as everything runs smoothly. Unless the entire equipment in the plant and throughout the shops is carefully watched, a gradual decrease in efficiency and an increase in wasted power is certain to occur. Some day when the shop is being worked to its full capacity, it is found that the boilers cannot supply the demand for power. The general foreman is concerned primarily with shop output. When he finds output hampered by the power house, he is anxious to correct the condition at once and is very likely to do it in the most direct and obvious way—by adding to the capacity of the boiler plant.

Probably the majority of shop foremen would resent the suggestion that they do not give the proper attention to the power house. It is true that in making the rounds of the plant they see the engineer and make sure that the plant is meeting demands and that there is no danger of shutting down. The need for reliability in the power house is recognized, but economy in the production of power unfortunately seems to receive only spasmodic attention and wasteful conditions may continue for a long time without being detected, as the following incident shows.

At a certain large railroad shop it became necessary to allocate the cost of power to various departments. To do this the coal used was weighed, an average value for evaporation was assumed, and the steam was apportioned on the basis of the theoretical consumption of the various engines, compressors and pumps. The result did not check with the measured power output and study showed that the actual efficiencies of both boilers and prime movers were far lower than what should have been obtained. The entire plant was later overhauled to correct the wasteful condition.

The cost of producing power is a considerable item in any shop and economy in fuel should be given close attention. It is interesting to note the opinion of a recognized authority on boiler plant efficiency, who recently stated that a large majority of plants possess and operate too many boilers, often twice as many as necessary. When conditions seem to demand additional boilers, it is always advisable to look carefully into the efficiency of those already in use. Power houses as a rule have a large overload capacity and additions to the boiler plant should not be necessary except when other shop facilities are enlarged.

Comprehensive Electrification Again Proposed

During the past two years a staff of engineers has been engaged in investigating the possible economies that might be effected by a comprehensive system for the generation and distribution of electrical energy in the North Atlantic states. The work was initiated and directed by W. S. Murray, formerly electrical engineer of the New York, New Haven & Hartford. One of the principal features of the proposed plan is the electrification of 19,000 miles of track at a cost estimated between $400,000,000 and $500,000,000. Despite this enormous capital expenditure a saving of 14 per cent on the investment is claimed for this so-called superpower system.

This is not the first time that such statements have been made with regard to comprehensive schemes for electrification. Nevertheless the investigation of specific cases has shown that the savings claimed could not be realized in practice and that the economies resulting from electric operation were not sufficient to warrant the large investment necessary except under very special conditions. The present plan is unique in proposing an interconnected system of steam and hydro-electric power plants to serve the railroads and industries. By this method it is claimed that one kilowatt hour could be delivered at the sub-station for the equivalent of two pounds of coal, or at a cost of one cent per kilowatt hour.

Assuming that the efficiency claimed for the superpower plants can be maintained, it is interesting to follow the reasoning by which the authors of the report reached the conclusion that the system would save nearly 60 per cent of the coal now used by the locomotives. The efficiency of the sub-station is assumed to be 85 per cent, the distribution 90 per cent, and of the electric locomotive 82.5 per cent. The output of the locomotive is therefore 63 per cent of the sub-station input, making the equivalent coal rate 3.18 lb. per kilowatt hour. The coal per kilowatt hour of the locomotive is assumed to be 7.5 lb., which makes the saving for the electric locomotive 57.6 per cent. This figure for locomotive coal consumption is altogether too high even for saturated steam engines, being almost identical with the value obtained under unfavorable conditions with saturated steam locomotives on the Chicago, Milwaukee & St. Paul. If the method used in computing the equivalent coal consumption under electric operation is applied to the steam locomotive, the result is quite different. An efficient modern locomotive uses about 2.5 lb. of coal per horsepower hour output while working. Standby losses, firing up, etc., increase this to 3.09 lb. per horsepower hour, or 4.14 lb. per kilowatt hour. On this basis the saving by electrification would be only 23 per cent.

It is not feasible to discuss the other sections of the report at length. The example given above will serve to show that the authors did not take the trouble to inform themselves of the capability of the modern steam locomotive. Much of the information presented is valuable, but the report suffers from a manifest tendency to favor the electric locomotive and not do justice to the steam locomotive.

COMMUNICATIONS

Car Wheel Grinding Data Desired

Asuncion, Paraguay, South America.

To the Editor:

Our locomotive and car shops are equipped with a car wheel grinding machine, manufactured by Messrs. Miller & Co., Ltd., Edinburgh. The working velocities of the grinding wheels and chilled cast iron car wheels ground are 1400 and 14 r.p.m. respectively and it takes from seven to eight hours to grind a pair of wheels. The grinding wheels used are made by the Carborundum Company, Ltd., size 16 in. by 1½ in., grit 24, grade Hx, bond H.D., with a recommended operating speed of 1,194 r.p.m.

I read some time back in the *Railway Mechanical Engineer* (June, 1920, pages 356 and 357) that the average time should be 38 min. including setting up.

I shall be very much obliged if you will kindly let me have details of grinding wheels used during the tests tabulated by you in the article referred to. E. Thomas,

General Manager, Central Railway of Paraguay.

The writer of the above letter requests data regarding certain specific car wheel grinding tests, but would doubtless be glad to benefit by the experience of any American railroad man familiar with the practice of grinding chilled cast iron car wheels. Railroad men in this country should cooperate with each other and with fellow workers in foreign countries just as much as possible. Mr. Thomas would probably be interested to know the particulars of methods used in American railroad shops to increase the output on car wheel grinding and the *Railway Mechanical Engineer* will be glad to transmit to him data regarding the type of grinding machine used, number of wheels ground per hour, relative abrasive and car wheel speeds, depth of cut, and any other information found by our readers to provide greater car wheel grinding machine production.—Editor.

Comment on the Purchase of Machine Tools

El Paso, Texas.

To the Editor:

Your editorial in the October number of the *Railway Mechanical Engineer* on the purchase of machine tools was read with a great deal of interest, and I heartily concur in your statements.

One of the most common faults of a great many railroads is the purchase of shop machinery based on first cost with the disastrous result that in a short time the machine is either worn out, or the weak parts have failed, and if the machine is worth repairing, new parts of stronger and more rigid construction are of necessity made and applied.

A machine to meet the demands of the ordinary shop must be of heavy and rigid design, capable of withstanding rough usage and at the same time turn out work to precision. The machine must also be adapted to the work ordinarily required of it. It is a mistake to continue the use of antiquated, time-consuming machinery in the shop, occupying space that is at a premium, where a modern machine capable of turning out more accurate work at a much more rapid rate ought to be installed.

During the war, when delivery of material was uncertain and when prices were fluctuating, a quotation did not amount to much, especially where used for an estimate. However, even at the present time when prices appear to again be dropping to normal, requests for quotations should state the probable date when such quotations would be used. It is often difficult in working up a budget to judge just when a machine may be purchased, but it would be a good plan to so advise the manufacturer in order that he could quote accordingly.

As to the sending of a representative of the manufacturer to the railroad contemplating the purchase of machinery, ordinarily such a trip is unnecessary as the mechanical officials of a railroad know pretty well what their requirements are. Of course, where an entirely new installation is planned it no doubt would be advantageous to have a machine representative on the ground who has had experience in planning and locating machinery to the best advantage for handling material in the railroad shop. F. G. Lister,

Mechanical Engineer, El Paso & Southwestern.

NEW BOOKS

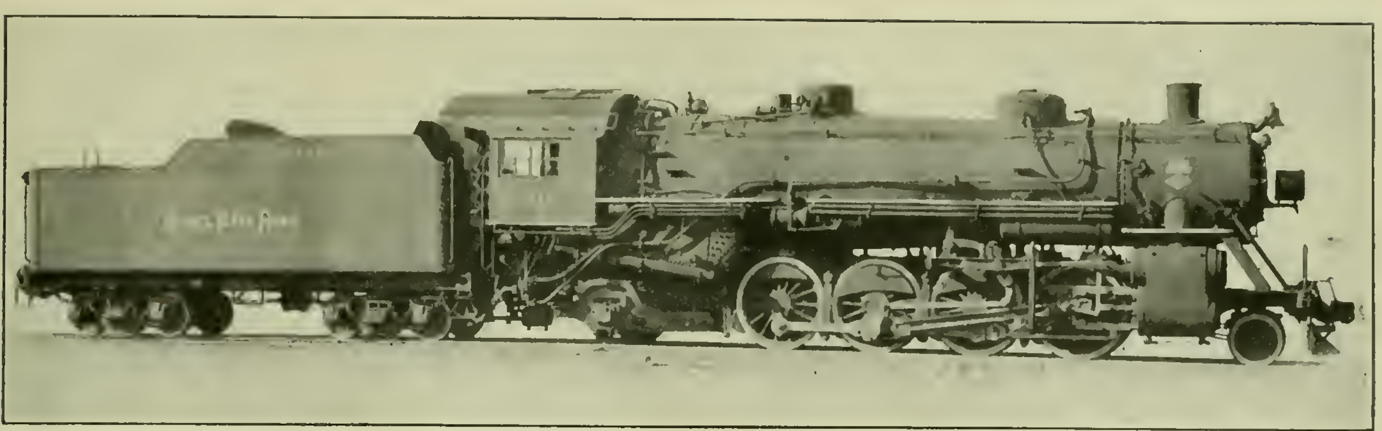
Air Brake Association Proceedings for 1921. *F. M. Nellis, secretary,* 165 *Broadway, New York.* 200 *pages,* 6 *in. by* 9 *in. Bound in cloth.*

In lieu of the twenty-ninth annual convention, which was postponed on account of railroad business conditions, the Executive Committee of the Air Brake Association held an open meeting at Chicago on May 3 and 4, 1921, at which time the necessary business of the association was transacted and the reports and papers presented in abstract only, discussion being postponed until next year's convention.

The proceedings of this meeting include the following reports and papers: Recommended Practice; Tests of Steam Heating Apparatus on Locomotives and Passenger Trains, Montreal Air Brake Club; Terminal Tests to Insure Effective as Well as Operative Brakes, Pittsburgh Air Brake Club; Schedule "UC" Brake Equipment; Brake Pipe Vent Valve, Central Air Brake Club; Air Consumption of Locomotive Auxiliary Devices; and Triple Valve Repairs, Northwest Air Brake Club. In addition to the committee reports and papers, the reports of the officers and a list of members are included.

Questions and Answers on the UC Equipment, 1921. 72 *pages,* 5 *in. by* 7 *in. Published by the Air Brake Association,* 165 *Broadway, New York.*

The Air Brake Association has just added to its list of educational books, one on the Westinghouse UC equipment. The book is intended for those men engaged in railroad service who desire to inform themselves on the construction, operation and function of the new UC passenger air brake equipment. It is a radical departure from much air brake literature in that it does not necessitate an intimate acquaintanceship with ports and passages. The subject has been covered not only by a text, but also by questions and answers. For those readers who desire general information in a minimum of time, the first fifty questions and answers have been prepared. For readers of the class who prefer the regular descriptive form, a summary has been included. Those readers who seek a more exhaustive treatment of the subject may find it in the complete questions and answers.



Mikado Locomotive Equipped with Booster

2-8-2 Type Locomotives for the Nickel Plate

Design Based on U.S.R.A. Light Mikado with Improvements in Details—Booster Handles 22 Per Cent Additional Tonnage

THE New York, Chicago & St. Louis (Nickel Plate) has lately received from the Lima Locomotive Works six Mikado (2-8-2 type) locomotives. The design was based largely upon the U.S.R.A. standard light Mikado, ten of which were allocated to the road, but a number of new and interesting features were added which make the locomotives among the best of this class.

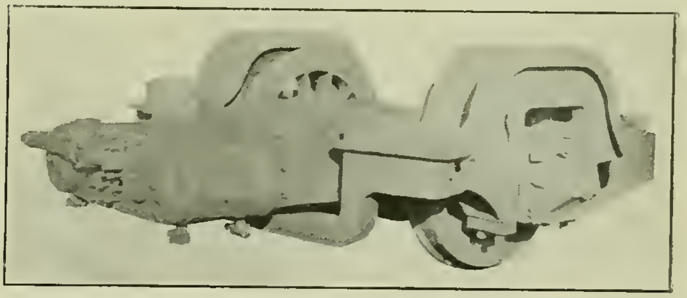
Front View of Trailing Truck with Booster

One of the locomotives was equipped with a booster furnished by the Franklin Railway Supply Company and provision was made on the other engines for the ready application of boosters at some future time. The trailer trucks are of the Commonwealth Steel Company's outside bearing Delta type, equalized with the drivers. The booster and truck are shown in two of the illustrations.

These locomotives have a tractive effort of 54,700 lb. without the booster and 64,200 lb. with the booster, an addition of 17 per cent. The cylinders are 26 in. by 30 in. and the drivers 63 in. outside diameter. The total weight of the locomotive equipped with the booster is 307,000 lb., of which 226,500 lb. are on the drivers, 20,500 lb. on the front truck and 60,000 lb. on the trailing truck. The driving wheel base is 16 ft. 9 in. and the total engine wheel base 36 ft. 1 in. The frames are fitted with a cast steel cradle and Franklin automatic adjustable wedges are used on all drivers. The valve gear is of the Walschaert type and control is by a Ragonnet type B power reverse. Cylinder and steam chest bushings are of Hunt-Spiller metal. The front truck is of the constant resistance type. Okadee automatic cylinder cocks and White single sanders to the front drivers only are among the other specialties. The front end main rod brasses are not adjustable but are provided with solid round bushings pressed in the same as on the side rods.

Instead of six-feed lubricators with feeds to the cylinders, these locomotives use four-feed lubricators, the cylinder feeds being omitted in accordance with the standard practice on the Nickel Plate which has been found to be entirely satisfactory.

The boiler is of the conical-connection type with combustion chamber and is equipped with type A top header superheater, Security brick arch and butterfly type firedoor. A Duplex stoker is used and particular attention was given to the cab arrangement to locate all necessary piping and fittings for the greatest convenience of the engineer and fireman. The boiler pressure is 200 lb. The firebox is 114⅛ in. long by 84¼ in. wide, which gives a grate area of 66.7 sq. ft. There are 216, 2¼ in. tubes and 40, 5½ in. flues, 19 ft. long. The heating surface of the firebox, combustion chamber and arch tubes is 280 sq. ft., the evaporative heating surface of the tubes and flues 3,497 sq. ft. and the superheating surface 882 sq. ft.



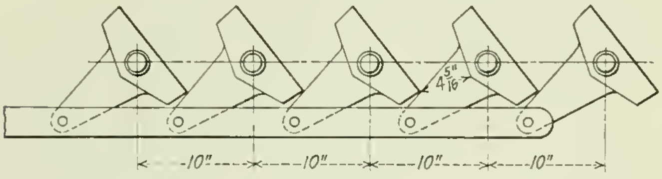
Side View of Trailing Truck with Booster

Special features include a cast steel ash pan, Woodard outside connected throttle with lever support designed to provide for expansion of the boiler, Nathan non-lifting injectors, Phillips top boiler check valves and Franklin power grate shaker.

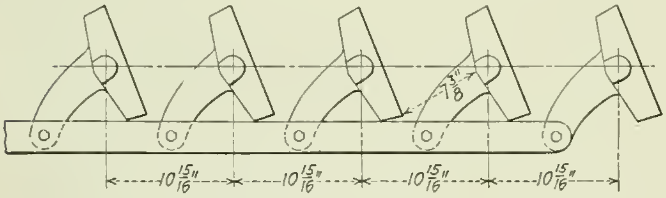
The two center arch tube plugs in the throat sheet are located on the radius and in order to get good threads the holes in the sheet are tapped out 3½ in., steel bushings screwed in and then welded around the edge, the arch tube plugs being screwed into the bushings. This may be considered a minor detail but attention to such points can save much vexation in the roundhouse.

The grate arrangement is of an entirely different design from that used on the U.S.R.A. standard light Mikados. The U.S.R.A. box grate had a straight horn perpendicular to the grate on the longitudinal center line. With this arrangement when the grates are wide open the maximum distance between the top of one grate and the bottom of the next grate is 4 5/16 in. In redesigning the grate arrangement, a curved horn was used which threw the center of the grate connection pin about 3½ in. ahead of the center. When these grates are wide open there is a maximum of 7⅜ in. from the top of one grate to the bottom of the next. The difference in design is shown plainly in the illustration.

Drop grates were used on the U.S.R.A. locomotives, but these were omitted on the new Mikados which have 10 rocking grates on each side of the firebox. With the large openings it is possible to dump the fire much more quickly and easily than with the old standard arrangement of drop grates and smaller openings in the rocking grates. The curved horn grate is not original on the Nickel Plate for it is the standard on the New York Central. However, the comparison between the two designs is interesting, especially as it is in connection with such points as this that the U.S.R.A. standard designs commonly have been criticized.



U.S.R.A. ARRANGEMENT



MODIFIED ARRANGEMENT

Grate Arrangement on Old and New Locomotive

As indicative of the value of the booster the record of a run made soon after the locomotive was received is of interest. This run was between Conneaut and Buffalo with a train of 50 loaded cars, 3 empty cars and 2 cabooses, the tonnage being 3,848. The regular tonnage for this class of power without a booster is 3,136. The excess tonnage handled was thus 712, an increase of 22.7 per cent over the regular rating.

The train left Conneaut at 8:40 a. m. and arrived at Tift street yard, Buffalo, at 4:32 p. m. The time on the division was 7 hr. 52 min. and the actual running time 5 hr. 45 min., an average speed while running of 19.9 miles an hour.

The booster was used eight times, as follows: Leaving Conneaut yard; on Springfield hill; pulling into and out of Girard siding; pulling into Cascade siding; pulling into and out of Pomfret siding; starting at D. A. V. & P. crossing, Dunkirk, and on Delaware hill. The approximate distance over which the booster was operated was three miles.

The maximum steam pressure was maintained over the entire division—even when the booster was operated the steam pressure did not fall and it was not necessary to lower the water level. In ascending Springfield hill the speed slackened to about seven miles an hour. The booster was then cut in and the speed was accelerated to approximately ten miles an hour before the top of the grade was reached.

It was necessary to stop at the D. A. V. & P. crossing in Dunkirk. After the crossing was cleared the train, although standing on a heavy ascending grade combined with a slight curve, was started with the aid of the booster at the first attempt. This is considered one of the hardest places on the division to start a train, and demonstrated the added drawbar pull obtained from the booster.

Causes of the Present Bad Order Situation

In an article recently published in the *Railway Age*, J. E. Muhlfeld makes the following comments on the bad order situation:

> Never have I seen freight cars generally in a more dilapidated condition, due to lack of proper upkeep. This situation is the result of several years of improper distribution, handling and use of cars, coupled with the making of costly repeated light repairs to keep them moving, whether loaded or empty, instead of making the ultimately less expensive substantial repairs, renewals and improvements at the time needed, to keep them in economical working order.
>
> My observations have led me to believe that the freight car situation offers one of the most costly propositions that the railroads are up against, both from a capital and operating expense standpoint, and that the cause for this is the lack of proper upkeep and the misuse of equipment during the federal control period; the neglect of preservation and resulting deterioration of metal in the car bodies and underframes due to corrosion, and the damage to underframes and superstructures because of deficient and defective draft gear and attachments. This latter item is something that is giving all of the railroads a great deal of concern, as when, for example in all-steel equipment, the strength of the underframes is reduced through corrosion of the floor and other plates, if the cars are permitted to run without any cushioning resistance for the buffing and pulling shocks, it does not require much rough yard handling or heavy train service to destroy the center sill and underframe structure, more particularly between the body bolsters and end sills. The fact that cars have been permitted to run without proper draft gear renewals and maintenance during the federal control period, and which practice is being continued at the present time, is due largely to the re-establishment by the U. S. R. A., and by various representative railroads, of the long since discarded transverse key type of coupler and coupler yoke connection, which couples the coupler with the center sills and enables the running of cars without draft gear.
>
> It can be readily understood what shocks the underframes of cars are subjected to, both buffing and pulling, when they are operated in this condition. Until the A. R. A. eliminates the use of such a device and restores the use of an arrangement which *couples the coupler to the draft gear only*, and requires the maintenance of the latter, the existing conditions will not only continue but become more aggravated. The use of the coupler center sill key attachment is also resulting in extraordinary damage to couplers. Even the latest A. R. A. heavy "D" type couplers have been found with not only various parts cracked and broken, but also with the shanks between the coupler head and the butt stoved up as much as from ⅝ in. to 1 in., due to extraordinary buffing shocks in combination with being run without draft gear in proper condition. Furthermore, the neglect to maintain draft gear and attachments, in combination with the many useless so-called "friction" types of draft gears that have been applied during the past 20 years, is responsible for much extraordinary center and end sill, draft arm and lug, body bolster, coupler and yoke damage.
>
> The modern freight car with its increasing ton-miles per day's work, in longer and heavier trains, requires *actual* maintenance to keep it in serviceable condition and the issuance of instructions to reduce the number of cars in bad order condition so that they will not exceed 4 per cent of the total will never take the place of needed actual repair and renewal work on existing equipment.

Plan for Electrifying Sections of Eleven Railroads

Superpower Report Provides for Consolidation of Power Supply in Region Between Boston and Washington

A REPORT called the Superpower Survey was transmitted to the President on November 5 by Secretary of the Interior Fall. It is the result of an investigation of the possible economy of fuel, labor and material resulting from the use of a comprehensive system for generating and distributing electricity to transportation lines and industries. The investigation was made by a staff of engineers working under the direction of W. S. Murray, consulting engineer, New York; in preparing the report they have endeavored to show how the economies of a power system on so large a scale will affect not only coal, but capital expenditures as well, and especially the output of human energy.

The plan provides for the interconnection of a large number of existing plants in the area shown in several of the illustrations by high voltage transmission lines. These lines would include and be extended to other points at which large power plants could be located advantageously at the mouths of mines, at tidewater, or along rivers suitable for hydroelectric developments. It would be necessary to derive more than 80 per cent of the power from coal. The maximum size of steam-electric stations has been fixed at 360,000 kilowatts. This limit has been determined by considering on the one hand the ability to transmit energy away from the plant and on the other the hazard incident to the possibility of destruction through unusual catastrophe. A steam pressure of 300 lb. would be used at the turbine throttle with a superheat of 230 deg. F. Proposed coal delivery routes are shown in one of the illustrations and six months' storage capacity for each plant is recommended.

Hydro-electric plants will be limited in size by stream flow and storage capacity. The principal developments are located on nine rivers, but as proposed the estimates for 1925 and 1930 can be justified only if they are included in an interconnected system, as otherwise their output cannot be economically absorbed by the power market.

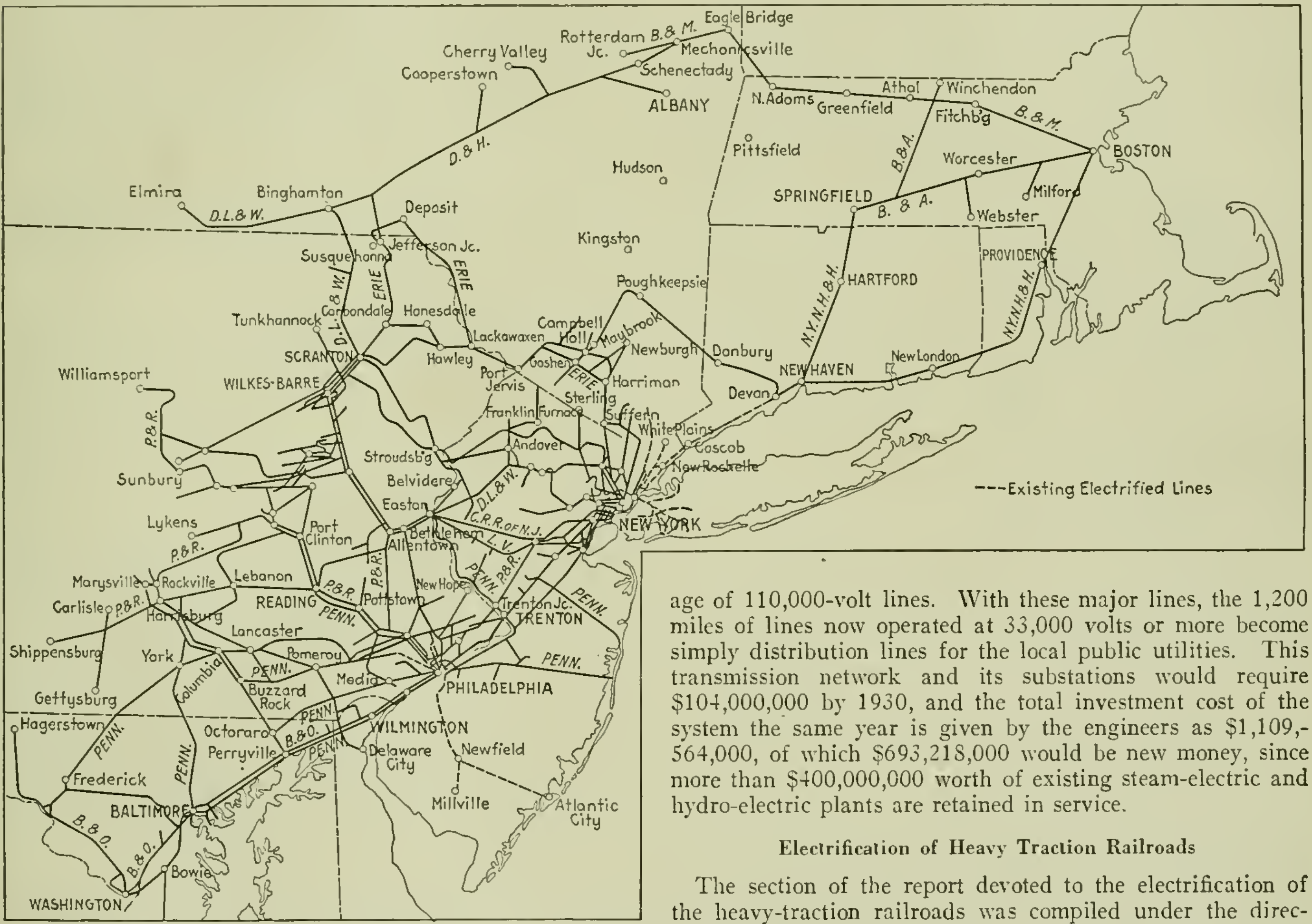


Fig. 1—Map Showing Class 1 Railroads Within the Superpower Zone for Which Electrification Is Recommended

For interconnection, 960 miles of 220,000-volt transmission lines are needed, together with five times that mileage of 110,000-volt lines. With these major lines, the 1,200 miles of lines now operated at 33,000 volts or more become simply distribution lines for the local public utilities. This transmission network and its substations would require $104,000,000 by 1930, and the total investment cost of the system the same year is given by the engineers as $1,109,564,000, of which $693,218,000 would be new money, since more than $400,000,000 worth of existing steam-electric and hydro-electric plants are retained in service.

Electrification of Heavy Traction Railroads

The section of the report devoted to the electrification of the heavy-traction railroads was compiled under the direction of Cary T. Hutchinson and N. C. McPherson; it presents results of even more general interest than the detailed analysis of the industrial use of electric power. The question of railroad electrification must be decided according to density of traffic; on this basis of the 36,000 miles of main line, yards, and sidings in this superpower zone, about 19,000 could be profitably electrified. This electrification would cost nearly half a billion dollars, but it is estimated that it would save from 11 to 19 per cent on the investment, or an average of 14 per cent per year. The following paragraphs contain an outline of the salient points brought out in this part of the report:

A consolidation of the roads within the district in question is first suggested which would make it possible to reroute much of the traffic as now handled. Unified operation by electricity would give much better conditions than any that could possibly be attained under unified operation by steam. There would be a new motive power, in which all units or parts designed for similar service would be identical and interchangeable. There would be a pooling of all power, with great reduction of reserves. Repair shops would be consolidated, and maintenance would become a standardized manufacturing job. Track capacity would be greatly increased, and certain tracks would be allocated to freight or passenger service exclusively. All freight trains would be run on schedule; the average speed would be more nearly the same and would be increased to at least 12.5 miles an hour needed to avoid the present punitive overtime payments. Enginehouse facilities would be much simplified by consolidation.

The great expense of any large increase in trackage should of itself force electrification; the total cost 20 years hence will be less if electrification is begun now than the cost of the added track and terminal facilities necessary under steam operation to provide for the inevitable 100 per cent increase in traffic within that time.

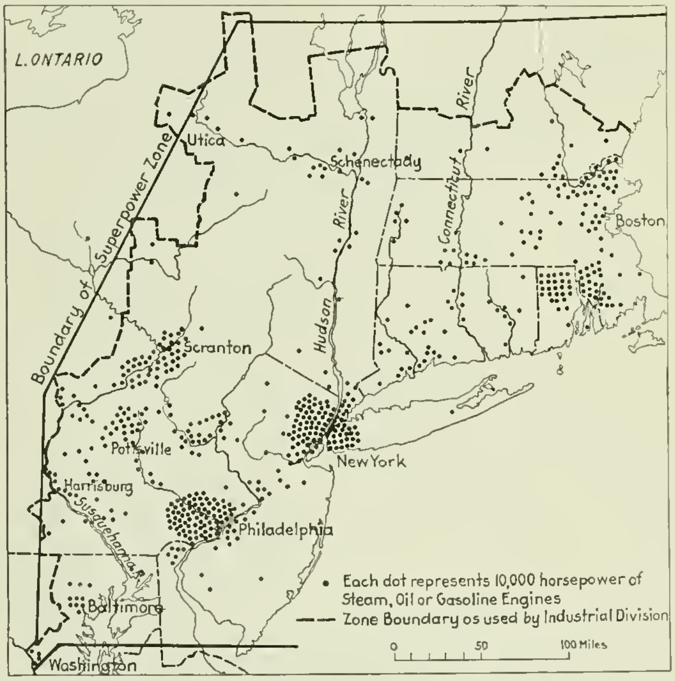


Fig. 2—Isolated Industrial Plants in the Superpower Zone

Motive Power

The entire freight service in the superpower zone can be handled by electric freight locomotives having two articulated two-axle trucks, each carrying two motors geared to the axle, the mounting being essentially the same as that in a number of locomotives now in use and similar to the usual street-car mounting. There would be two classes of locomotives of this type—a light one carrying 80 tons on drivers and having a continuous drawbar pull of 22,000 lb. at 25 miles an hour, and a heavy one carrying 110 tons on drivers and having a continuous drawbar pull of 30,000 lb. at the same speed. These units can be combined in any reasonable number; the total load on drivers can be made equal to 80,110,160,190,220 tons, or as much more as may be desired, being limited only by the strength of the draft rigging. A train can, of course, be double-headed, and a total tractive pull up to the maximum now in use can be obtained, with at least double the present speed.

For passenger service a similar arrangement would be used; that is, two articulated two-axle trucks, with one motor geared to each axle. The motors may be practically the same as those in the freight locomotives, the only difference being a change in gear ratio. The passenger locomotive, however, would have leading and trailing trucks, with either two or four wheels, and the total weight would be redistributed. This passenger locomotive would be of two weights, the light one having 60 tons on drivers, and the heavy one 90 tons. These also may be combined, like the freight locomotives.

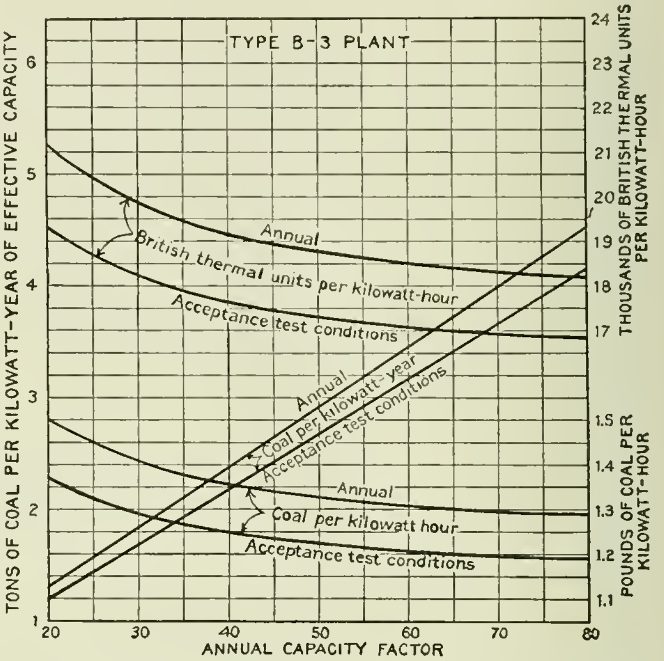


Fig. 3—Estimated Unit Performance of One of the Base-Load, Steam-Electric Plants; Plant Uses Bituminous Coal, Stokers and 20-Tube High Boilers

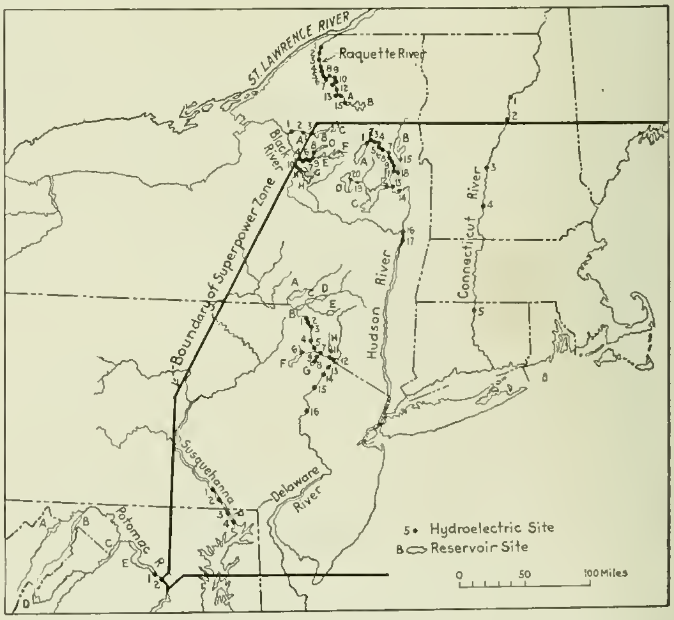


Fig. 4—Principal Hydro-Electric Resources of Superpower Zone

For the switching locomotives, one size will be adequate, with 70 to 75 tons on drivers, of the same type as the freight locomotive. Substantially the same frame and running gear can be used, with motors of less capacity.

All three types of locomotives will have the usual overload capacity, and all will be able to operate in starting and accelerating at 25 to 30 per cent adhesion. These suggested sizes and types of locomotives can, of course, be varied greatly without sacrificing the advantage of unified electric operation, but identity of types for the same service throughout the superpower zone is essential.

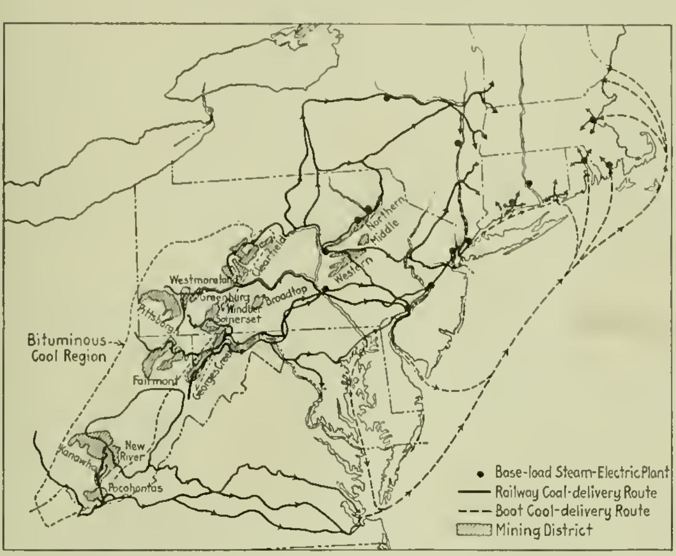


Fig. 5—Location of Principal Coal-Delivery Routes from Bituminous Regions to Base Load Steam-Electric Plants in 1930

The only two systems that are applicable to general traction within the superpower zone are the 3,000-volt direct-current system and the 11,000-volt (or higher) alternating-current system, both with overhead distribution circuits and rail return. Both of these systems are in successful use, and both can no doubt be designed and constructed to give satisfactory service in the zone.

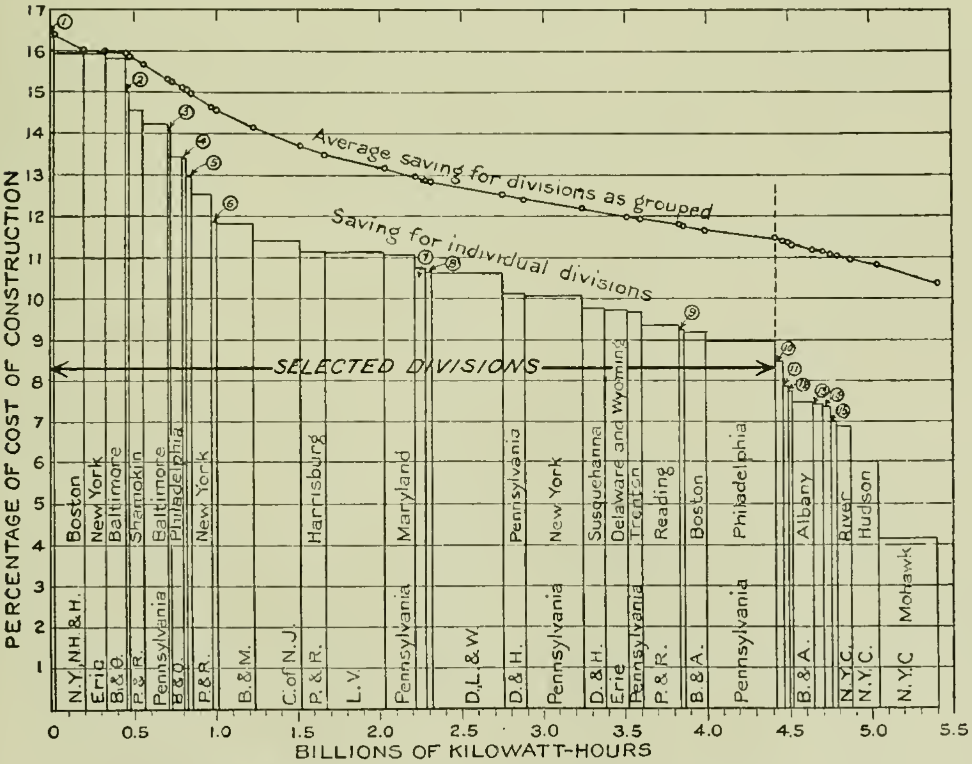


Fig. 7—Saving Effected by Electrification of Heavy-Traction Railroads in Percentage of Construction Costs, Not Including Savings in Wages

Systems of Electrification

In order to avoid some uncertain elements in the estimates of the cost of the alternating-current system it was decided to base all estimates, both of operation and of construction, on the 3,000-volt direct-current overhead system. Substantially the same results in money could, however, be obtained with the alternating-current system, certain gains being offset by certain losses.

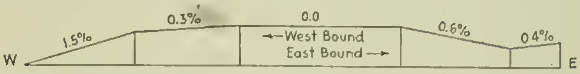


Fig. 6—Profile Used for Making Calculation of Power Requirements

It was evident at the outset that it would not be adequate to study the roads as units, but that a study should be made of the operating divisions of the railroads. A study of a railroad system as a whole, even if it lay entirely within the zone, would yield only average results, which might make a poor showing, whereas some of the divisions treated separately might make a good showing. It was, therefore, decided to ask each of the Class 1 railroads within the superpower zone, of which a list is given above, to answer questions asking for certain fundamental data as to roadbed, equipment and traffic. This information, as with all other information sought, was to cover the year 1919.

Class 1 Railroads Within the Superpower Zone

Boston & Maine
Boston & Albany
New York, New Haven & Hartford
New York Central
Delaware & Hudson
Ulster & Delaware
New York, Ontario & Western
Lehigh & New England
Lehigh & Hudson River
Erie
Delaware, Lackawanna & Western
Lehigh Valley
Central of New Jersey
Long Island
Pennsylvania
Philadelphia & Reading
Western Maryland
Baltimore & Ohio

In addition to the data from the railroads, two large companies, the General Electric and the Westinghouse, were asked to prepare estimates of cost of substation equipment, of electric locomotives, of catenary construction, and of other facilities—all as of the year 1919. Similar data were also asked of the Ohio Brass Company and one or two other companies.

Electrical Energy Required

The electric energy required for the railroads is determined from the records of lines already electrified, with proper allowance for variations in the conditions of operation, and from calculations based on the profile and the alinement of the roads considered and the efficiency of their locomotive and distribution systems.

In fixing the units of energy for the different operating divisions much weight is given to the results of the New Haven service modified as required by the profile and alinement of the division under examination.

Other records of electric energy for locomotive-drawn trains, both freight and passenger, were obtained from the Chicago, Milwaukee & St. Paul, New York Central and the Pennsylvania. Tables published in the report show the amount of power used on these roads for freight, passenger and switching service.

The second method of determining electric energy required consists in calculating, from profile and alinement, the work due to normal train resistance and adding to this the net work done against gravity, plus the work due to curvature, plus the work due to acceleration.

Cost of Electrical Equipment and Saving Effected

The quantity of coal burned by a steam locomotive necessary to do one kilowatt-hour of work at the rim of the drivers is estimated at 7.5 lb. Equivalent coal for electric locomotives is uniformly taken at 2 lb. per kilowatt-hour for energy delivered at the substation. All losses of energy in transmission and conversion from the power station to the substation are included in this figure. To make the costs justly comparable throughout, a unit price was adopted for railroad coal in each section: the cost per ton as thus fixed for the several sections of the zone is $5, $5.50 and $6 for the south, central, and northern sections, respectively. These costs include the prorated cost of fuel and water stations.

It is assumed that the railroads will purchase electrical energy delivered at high pressure at substations on or near the railroad right-of-way at the flat rate of one cent per kilowatt-hour.

Maintenance of the electric distribution systems, is taken at $600 per mile for main track and $400 per mile for yard track. The cost of operation and maintenance of substations is based on $1.50 per kilowatt per year of capacity, giving 0.7 mill per kilowatt-hour for a capacity factor of 25 per cent.

It is assumed that there will be an increase in ton-miles per electric locomotive-hour of 33 per cent and a consequent reduction in crew wages per ton-mile of 25 per cent. For passenger service no data are at hand; a general consideration of the subject does not indicate a material saving in wages necessary on account of train crews and therefore none is assumed.

TABLE NO. 1

Cost of Catenary System and Electric Equipment

(1) Catenary system:			
	Miles	Cost	
(a) Single track..............	175	$2,013,000	
(b) Double track..............	68	1,700,000	
(c) Three-track	9	291,000	
(d) Four-track	42	1,625,000	
(e) Yards and sidings.........	221	1,658,000	
(2) Total	......	....	$7,287,000
	Capacity		
(3) Substations ....kilowatts	82,100	....	4,926,000
(4) Locomotives:			
	Number		
(a) Freight	43	$3,440,000	
(b) Passenger	55	4,576,000	
(c) Switcher	41	2,657,000	
(5) Total	139	....	10,673,000
(6) Sum of specified items.....	......	....	$22,886,000
(7) Allowance for unspecified items, 10 per cent of (6)............	......	....	2,288,600
(8) Overhead, 20 per cent of (6).....	......	....	4,577,200
(9) Total gross cost...........	......	....	$29,751,800
	Total tonnage		
(10) Credit for released steam locomotives	30,300	....	*6,060,000
(11) Net cost.................	......	....	$23,691,800

*Present value.

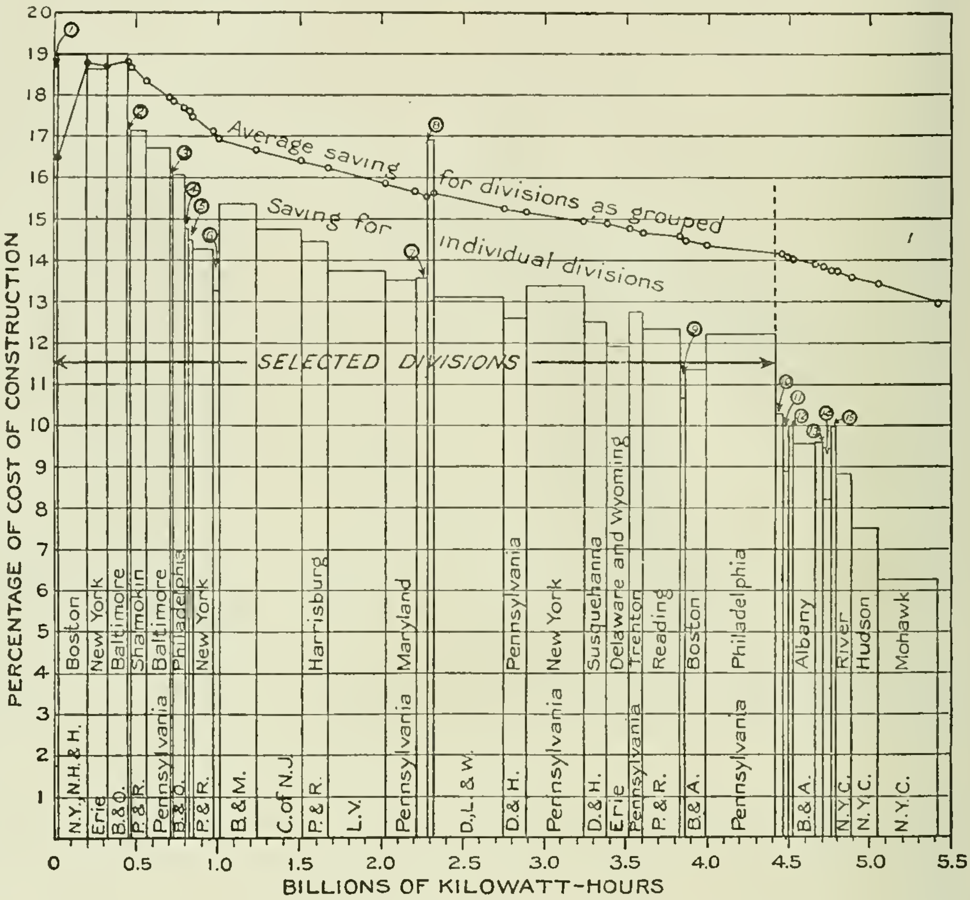


Fig. 8—Saving Effected by Electrification of Railroads, in Percentage of Construction Cost, Including Saving in Wages

It is estimated that the electric switchers will do 50 per cent more work per hour than the steam switchers, and that consequently the wage account for the same service will be reduced by 33 per cent.

In table No. 1 are listed the costs of electric equipment for a typical section of line necessary to make the savings possible with electric operation. The costs given in the table are based on the answers of questions sent to railroads operating within the superpower zone, and the values of track mileage, locomotives, etc., given in the table, are the sum of those values given in the answers received. The total net cost as given in the table represents only the cost of the equipment listed in the table and is indicative of the cost of the larger amount of equipment which could be used economically for electrifying the railroads in the zone.

Costs of catenary are based on estimates made by manufacturing companies which were checked by estimates made by the Chicago Smoke Abatement Commission's report.

The required sub-station capacity, item 3, table No. 1, is based on an analysis of existing installations.

The number of locomotives required is based on an annual mileage of 40,000 for freight, 75,000 for passenger and 40,000 for switcher locomotives. Estimates of costs of locomotives were based on those made by manufacturing companies. These estimates are stated in cost per lb. for the three classes as follows: 40c. per lb. of total weight for freight locomotives and switchers, having all of the weight on the drivers and 45c. for passenger locomotives, equivalent to $800 per ton on drivers for freight locomotives and switchers, having 70 per cent of the weight on the drivers, and $1,300 per ton on drivers for passenger locomotives. The total weight on drivers of the electric locomotives is the product of their number by the average weight on drivers of the steam locomotives on the division. The minimum number of electric locomotives required for each division is 50 per cent of the corresponding number of steam locomotives, even if the number based on mileage is less than 50 per cent.

Item 8, table No. 1, covers overhead allowance of 20 per cent for engineering, interest and contingencies which are difficult to predetermine.

It is assumed that all steam locomotives released by electrification can be used and it is also assumed that the average condition of the locomotives released is 50 per cent new. The value of a new locomotive in 1919 is taken at 18c. per lb. of total weight, and the salvage value at 2c. per lb.

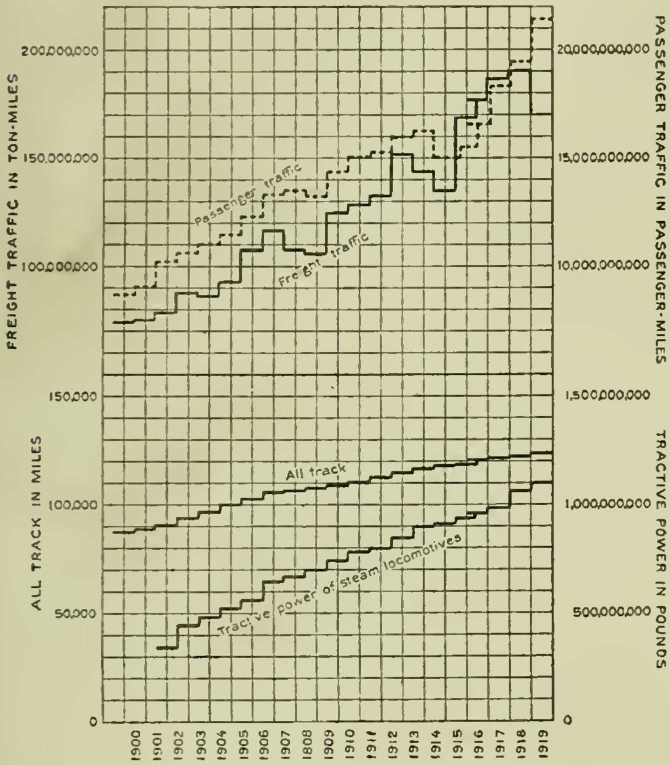


Fig. 9—Growth of Steam Railroads in the Superpower Zone, 1900 to 1919

Conclusions

Following the procedure outlined in the preceding paragraphs, a study was made for all the Class 1 railroad systems within the superpower zone except the Ulster & Delaware, the New York, Ontario & Western, and the Western Maryland. The first two were omitted after a preliminary examination because their traffic was too light to warrant electrification. The Western Maryland was omitted because only a small part of its traffic is within the zone; the preliminary examination, however, indicates that the Western Maryland traffic would justify electrification. This left a remainder of 13 railroads in the zone that were studied. The Boston & Albany was included with the New York Central and the Long Island with the Pennsylvania. It was not possible in this study to adhere strictly to the limits of every operating division reported by the railroads, and some divisions were therefore consolidated into routes. The number of divisions or routes range from one on the Boston & Maine to nine on the Pennsylvania and aggregated 40 for the 13 roads.

The results of the study are given in Figs. 7 and 8 which show for each of the 40 divisions the annual saving, in percentage of the net cost of electrification, plotted against the energy required, in kilowatt-hours per year, together with the accumulated average percentage of saving for the divisions as grouped. Fig. 7 shows the saving exclusive of the saving in crew wages, and the divisions are arranged in the order of percentages. With these results as a criterion of economical electrification the "selected divisions" are assumed to be all that show a saving of nine per cent or more. The group of divisions thus selected shows an average saving of 11.4 per cent. It includes 30 of the 40 divisions examined, comprised in 11 of the 13 systems. The saving, including the wage saving, for the 40 divisions, is shown in Fig. 8. For the "selected divisions" these savings range from 10.6 to 19 per cent and average 14.2 per cent. The total energy required annually for these 30 divisions would be 4,400 million kilowatt-hours, and the maximum demand approximately 850,000 kilowatts.

The low percentage of saving shown by the divisions not included in the selected group, except those of the New York Central, is due to light traffic. On the New York Central the train cost of transportation, the cost of maintaining steam locomotives and the cost of coal per mile are lower than on any other system, owing in part to the fact that this is a water-level road with a large amount of through traffic; these are favorable conditions for economical steam operation and afford less opportunity for saving by electrification.

The amount of electrification recommended includes 48 per cent of the route miles, 53 per cent of the main track miles, 64 per cent of the yard track and 58 per cent of all track owned by the 11 selected roads in the district. The net cost of electrification of all the selected divisions would be $570,000,000, and the net annual saving in operation, including the saving in wages, $81,000,000 equal to an average of 14.2 per cent of the entire group, ranging from 10.6 per cent for the New York, Susquehanna & Western division of the Erie to 19 per cent for the New Haven-Boston route of the New Haven.

The growth of traffic, both freight and passenger, of track, and of tractive power for the Class 1 railroads in the superpower zone from 1900 to 1919 is shown in Fig. 9. The annual rate of growth has been 5.3 per cent in passenger-miles, 4.5 per cent in ton-miles, 0.75 per cent in all track, and 6.6 per cent in tractive power of locomotives.

The amount of money required for electrification is $570,000,000. This figure is based on costs prevailing in 1919, but at costs as of June, 1921, it would be reduced by 18 per cent, to approximately $467,000,000, and before this construction can be undertaken there would be further material reductions. Probably five years from now the entire work outlined could be done for not more than $400,000,000. Good railroad authorities have stated repeatedly that more that $1,000,000,000 a year is needed by the railroads of the United States for extensions and betterments. The part of this total to be allocated to the superpower zone, as determined by the number of locomotives, would be $150,000,000. The amount required for normal extensions and betterments for three years would, therefore, be sufficient to electrify the 30 selected divisions of the railroads in this territory, with an annual saving of more than 14 per cent. The most valuable feature of the change, however, is not the amount saved, but the great increase in maximum capacity of existing trackage and general advantages of electric operation.

These figures indicate that with a return of normal financial conditions all these lines should be electrified before further great expenditures have been incurred to increase in a minor degree the capacity of the existing tracks and yards. Steam operation cannot satisfactorily meet the conditions of the crowded terminals herein described as the superpower zone; electric operation can easily do it.

Method of Laying Out Walschaert Valve Gear

Designing to Compensate for Angularity; Fixing Principal Dimensions of Parts

BY J. J. JONES
American Locomotive Company, Schenectady, N. Y.

WHILE the Walschaert valve gear had been previously used on American built locomotives, its present almost universal application may be said to have begun with the Baltimore & Ohio Mallet locomotive built by the American Locomotive Company at its Schenectady plant and exhibited at the St. Louis exposition in 1904.

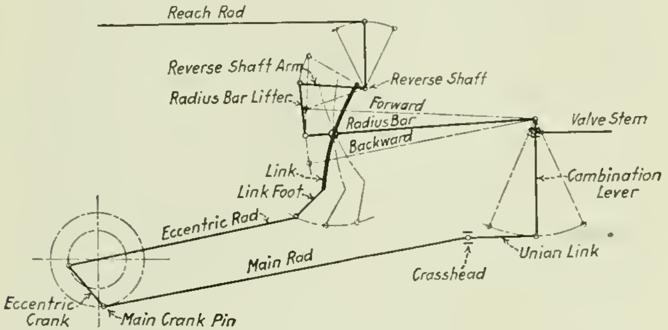


Fig. 1

This engine attracted a great deal of attention in the railroad world at that time, not only on account of the valve gear, but also because it was then the largest and most powerful locomotive in the world, and marked the introduction of the Mallet as it is now known on American railways.

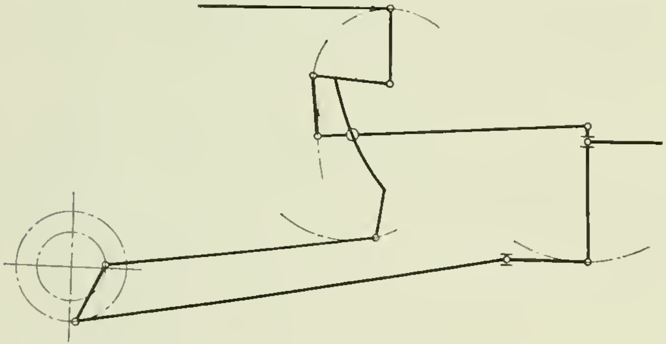


Fig. 2

The writer's first practical experience with the Walschaert valve gear was as elevation draftsman in the building of this locomotive and as he has since been closely connected with the designing and application of this gear an outline of his method of laying it out may be of interest. In submitting this it is assumed that the reader has a good understanding of locomotive design and it is not necessary to explain the construction of the valve or flow of steam to and from the cylinder.

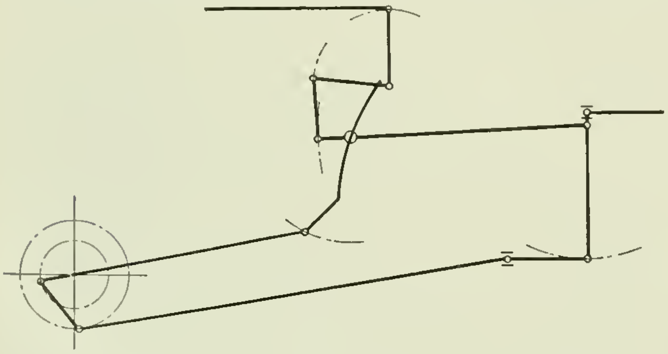


Fig. 3

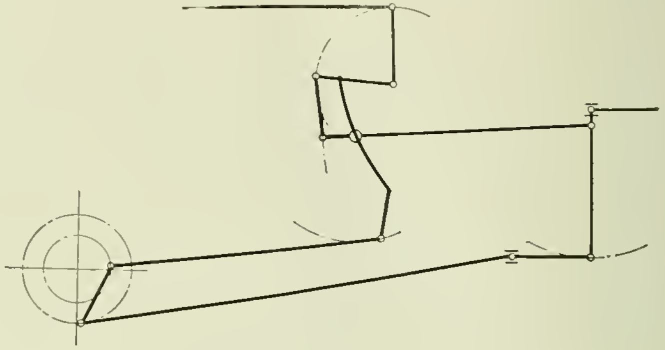


Fig. 4

Before starting the layout of the gear the general design of the engine is studied to determine which of the various arrangements of reverse shaft, etc., is most suitable. Diagrams of several arrangements in common use are shown by Figs. 1 to 6.

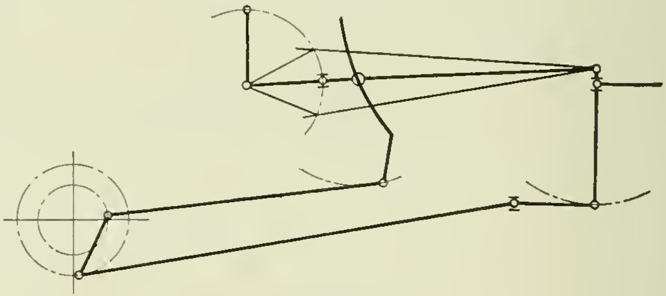


Fig. 5

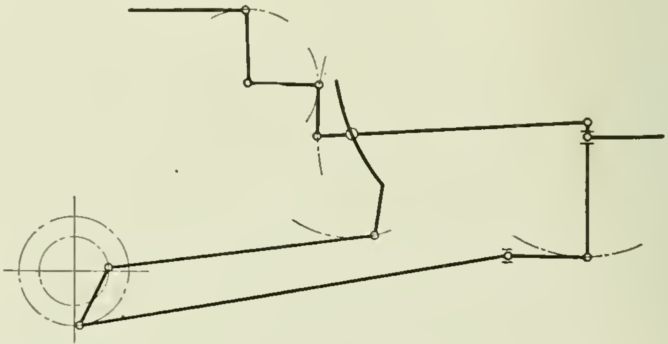


Fig. 6

The arrangement most used by the American Locomotive Company is shown in Fig. 1. This is arranged for inside admission with the eccentric crank leading the main crank pin and the radius bar in the top of the link in the forward motion. With this arrangement the irregular movements due to angularity of the main rod are compensated by the angularity of the eccentric rod, consequently it will produce the nearest to perfect results as to cutoffs, etc., at all positions of the reverse lever.

The arrangement shown in Fig. 2 is similar to Fig. 1, but the eccentric follows the main crank, which places the radius bar in the bottom of the link in forward motion.

An arrangement for outside admission, with the eccentric leading and the radius bar in the bottom of the link in forward motion is shown in Fig. 3. This, on account of the leading eccentric, has the same advantage as regards perfect results for all reverse lever positions as Fig. 1.

Fig. 4 is the same as Fig. 3 except for the following eccentric and forward motion in the top of the link.

Fig. 5 shows an arrangement in which the radius bar lifter is in the form of a slide carried by the reverse shaft arm.

Fig. 6 shows an arrangement similar to Fig. 2, except that the center of the reverse shaft is located back of the link. The names of the various parts are indicated in Fig. 1.

After selecting the arrangement to be used, it is necessary to decide where it will be best to locate the center of the link and the vertical center line of the combination lever on the elevation drawing, having in mind proper clearances from other parts of the engine. The location of the link should, if possible, be such that the radius bar will not be longer than the eccentric rod, a good arrangement being to make the radius bar approximately three-quarters the length of the eccentric rod.

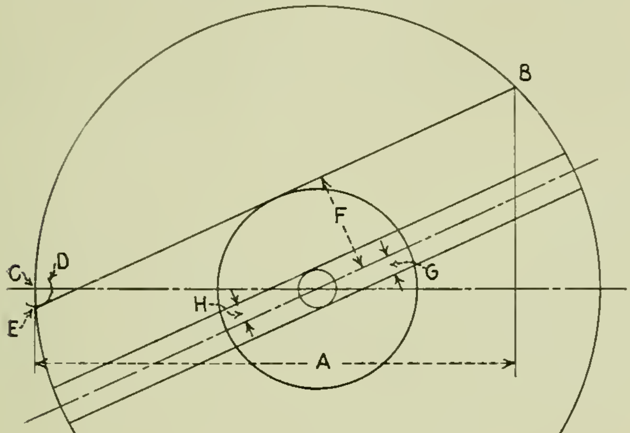


Fig. 7

It is also advisable to locate the link as low as possible so as to avoid excessive length of link foot. It should not, however, be so low as to involve an excessive angle between the radius bar and valve stem at the lower end of the link unless provision is made in the valve stem guide to withstand the higher thrust.

Having settled these points, the designer must decide what valve setting is to be used; viz, maximum valve travel, steam lap, lead and exhaust clearance or lap. These dimensions are usually decided from previous experience with similar locomotives so that it is seldom necessary to do more than pick out the setting suitable for the case in hand; however, the setting may be decided graphically by means of the Reuleaux or similar diagram.

The Reuleaux diagram, Fig. 7, which is probably the most easily understood, is constructed as follows: Draw a circle whose diameter is equal to the assumed valve travel, then on the horizontal diameter measure a distance that is the same per cent of the whole diameter as the desired maximum per cent cut off and draw a vertical line to point *B* which will correspond to the cut off position of the crank pin if the circle is also considered as the path of the crank pin and dead center or beginning of the stroke at point *C*.

Now draw an arc *D* of radius equal to the assumed lead and then draw line *E-B* tangent to arc *D*. The required steam lap is then shown by the distance *F*.

Exhaust clearance or lap is determined by drawing a line parallel to line *E-B* through the desired release or closure position of the crank pin; exhaust line and line is shown by a line through the center of the circle. *H* indicates exhaust clearance; *G* indicates exhaust lap.

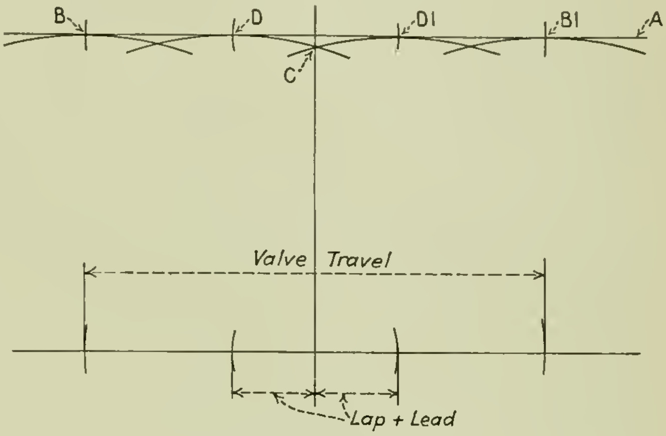


Fig. 8

As this diagram does not take into consideration irregularities due to angular movements of the main rod, etc., the results will not be exactly the same as will be obtained on the engine, but will be a close approximation only and, therefore, if a certain maximum cut off is desired, it is best to make the lap, travel, etc., such that the diagram will show about one per cent longer cut off.

The center line layout of the gear is now started (see Fig. 10) making it to as large a scale as convenient and as accurate as possible, if necessary, using a magnifying glass to insure that centers are exactly on the intersections of lines. The next step is to lay out the center lines of axle, crank pin circle, cylinder, crosshead wrist pin in center of stroke, link, valve stem and vertical center line of combination lever.

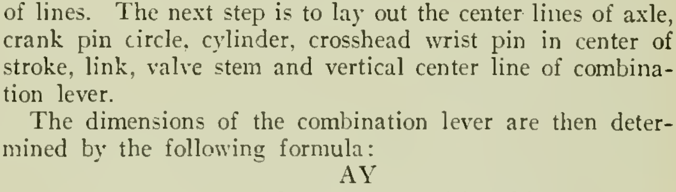


Fig. 9

The dimensions of the combination lever are then determined by the following formula:

$$A : B : : X : Y \text{ or } \frac{AY}{B} = X \text{ in which}$$

A = (Lap + lead + 1/32 in.) × 2
B = Equals stroke of engine.
Y = Distance between radius bar and union link pin
X = Distance between radius bar and valve stem pin
(The 1/32 in. in the formula above is to compensate for lost motion in the finished gear.)

A distance equal to the lap plus the lead is then measured off on the valve stem center line each side of the vertical center line of the combination lever, also half the valve travel as shown in Fig. 8. Then with these points as centers and radius *X*, draws arcs which intersect the vertical center line at point *C* and are tangent to a line *A*, which shows the highest position of the radius bar pin.

The points *B* and *B*1 are then located on line *A* to show the amount of movement of the radius bar pin necessary to obtain the required valve travel, which is determined as indicated in Fig. 9 and shown by the dotted line marked "link movement."

The next step is to locate points *D* and *D*1 equidistant from the center line for about half full link movement.

Then from point *C* with the distance to the center of the link as radius, the arc *E* (Fig. 10) is drawn which shows the central position of the link, and from the center of the link with the same radius arc *F* is drawn on which the centers of the link at full swing front and back are later located.

It is then necessary to decide the maximum lift of the link block to be used, allowing proper clearances at the ends of the link, and draw the link circle *G* which is used only as a limit line beyond which the link block must not travel.

With a radius equal to the radius of the link and *B* and *B*1 (Fig. 8) as centers, arcs *B* and *B*1 are drawn which at their intersection with the link circle show the maximum possible movement of the link block. Shorter arcs are also drawn from points *D* and *D*1 as centers.

Centers are now located on arc *F* equidistant from point *C* so that when an arc is drawn through the center of the link it will intersect arcs *B* and *B*1 inside of the link circle. This locates the full swing of the link.

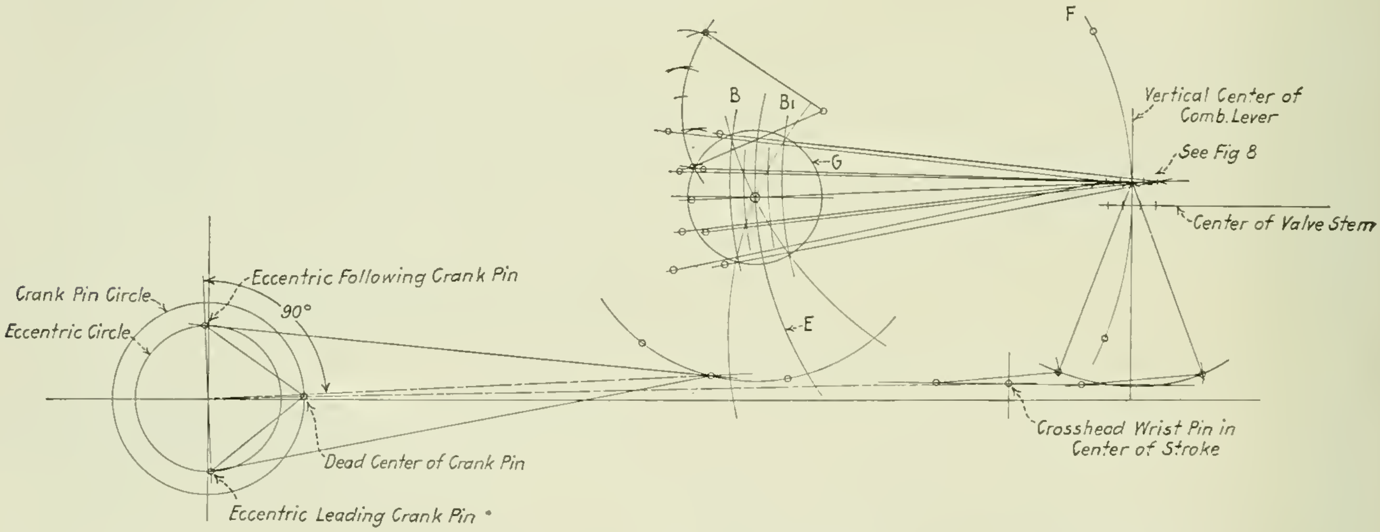


Fig. 10

The next step is to locate the link foot pin and find the diameter of the eccentric circle that will give the angular swing of the link that is shown by the arcs of full swing.

These are determined by trial as there is no accurate rule for determining them and must be such that when the eccentric is located 90 deg. from the center line through the axle and link foot pin the resultant swing of the link will be the same each side of the center and same amount as shown by the arcs of full link swing.

In this connection the nearest approximation of the correct location of the link foot pin known to the writer is shown by diagram in Fig. 11. This, however, usually gives a point that is two or three degrees too far back and therefore should be considered only as a simple method of finding the first trial center.

After the link foot pin position and the diameter of the eccentric circle are determined, the length of the eccentric crank is found by measuring the distance to the dead center of the crank pin as shown, the eccentric being either leading or following the crank pin as required by the gear arrangement.

Lines are now drawn from points *B*, *B*1, *D*, *D*1 and *C* through the intersections of their arcs with the arcs of full link swing to show the center lines of the radius bar for these positions of the link block, and to locate points to show corresponding positions of the radius bar lifter pin. Then with these points as centers and the length of the radius bar lifter as radius, draw intersecting arcs to fix points from which to locate the center of the reverse shaft so that with the length of reverse shaft arm decided on the suspension pin for the radius bar lifter will travel as near as possible to the points thus found.

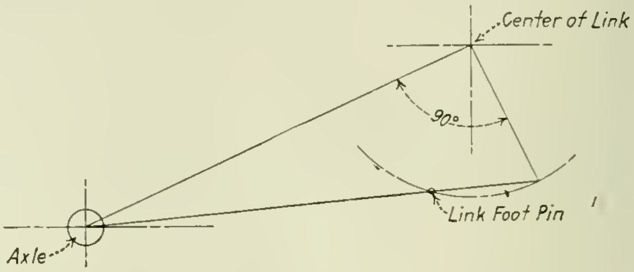


Fig. 11

It now remains only to determine the correct length of the union link, which should be such that the angle of swing of the combination lever will be the same each side of its vertical center line. The proper length is equal to the distance from the crosshead wrist pin to the lower pin of the combination lever when laid out for the end of the stroke, and not when laid out on the vertical center line.

The reader will no doubt have noted that the dead center positions of the crank pin in the layout are on the line drawn through the center of the axle and crosshead wrist pin at the center of the stroke and that these dead centers do not check with the true dead centers when the center line of the cylinder is above the center of the axle.

While the latter gives the actual dead centers that will be used by the valve setter, greater accuracy in the length of the eccentric crank is obtained by using the centers as shown, the slight error being in the length of the eccentric rod if measured on the layout.

The amount of this error may be determined by revolving the eccentric around the center of the axle the small angle represented by the distance from the assumed to the true dead center; then the distance from the eccentric to the center of the pin in the link foot is the correct length of the eccentric rod.

If the laying out is carefully done no adjustments will be found necessary, when setting the valves in the shop, except possibly a slight lengthening or shortening of the eccentric rod or radius bar to compensate for unavoidable inaccuracies in workmanship.

Operating and Maintaining Oil Burning Locomotives*

Oil Tanks; Piping; Location of Burners; Drafting; Preventing Air Leaks; Cleaning Soot from Flues; Maintaining Oil Temperatures

The first attempt in the United States to burn crude oil in the firebox of a locomotive was made at Santa Paula, California, in October, 1894. The subsequent study of combustion soon led to a better understanding of the firebox and boiler design and realizing the many advantages to be gained by the use of oil as fuel, every effort was made to develop the most efficient burner and drafting arrangement. Most obstacles were overcome and in a comparatively short time a high degree of efficiency was attained.

Crude oil possesses many advantages over other fuels and in the West its use soon becomes widespread. At no time during the past few years has the production of crude oil in the United States been sufficient to meet requirements, and records for June, 1921, show the consumption of 81,000 barrels per day in excess of production, which deficit was and is being supplied from the Mexican fields.

Daily production, United States, June, 1921	1,346,833 bbls.
Imports from Mexico	340,175 bbls.
Total	1,687,008 bbls.
Daily consumption	1,427,367 bbls.
Amount placed in storage daily	259,641 bbls.

At the present rate of consumption we are told by geologists that the crude oil supply in the United States will be exhausted within a few years as there now remains but about 60 per cent of the original supply underground. With this prospect in sight it is small wonder that strenuous efforts are being exerted to conserve the remaining supply by maintaining and operating oil burning locomotives as economically as possible. At the present time there are about 41 railroads operating in 21 states which burn oil for fuel, some, however, on a very small part of their power.

The maintenance of the locomotive rests largely with the enginemen. The medium through which the maintenance is accomplished is the work report and its correct rendition. This means that if the locomotive is to perform economically at its maximum capacity specific information must be given to the roundhouse force as to just what defects were noted under actual operation. Maintaining an oil burning locomotive would be a very simple task if a thorough and accurate report of defects noted by engine crews were reported at the end of each trip. "Don't Steam" covers a multitude of sins but the worst sinner of all is the man who writes it on his work report, with no further detail, and then has writer's paralysis.

Generally speaking there are but few points of difference in maintaining an oil burning locomotive as compared with a coal burner and these points of difference affect the design of tender, oil piping and firebox arrangement. The fuel oil tank is constructed of ⅜-in. material and the capacity is approximately 3,000 gallons—a coal equivalent of about 17 tons on the basis of 42 gallons per barrel and 4 barrels of oil equal to a ton of coal. On filling the square tank a 2-in. space is left in the top and on semi-cylindrical 6 in., to allow for expansion when the oil is heated. The ratio of expansion is one per cent for each 25 deg. F. increase in temperature. Fuel tanks are provided with a measuring rod designed to show inches on one side and gallons on the other so that accurate measurements may be obtained at all times.

Oil flows to the burner by gravity on all types of locomotives except the Mallet, in the tender of which is used six pounds air pressure. The oil piping arrangement conveys the oil from the tank to the burner, from which it is sprayed into the firebox by steam. This conduit is two inches in diameter and passes through a superheater four inches in diameter which is used, in addition to the tank heater, to heat the oil before it reaches the firebox. The tank heater should be so constructed and maintained as to keep the oil at the proper temperature, the oil feed line should be free from leaks, with as few elbow joints as possible; metal with flexible joints is preferable to rubber. The cut-out or safety valve on the tender, the blow-back valve, superheater and firing valve should all be in perfect working condition. Burner should be of suitable size, varying from one inch to three inches according to size of firebox, clean and lined up about 60 in. from the flash wall to insure perfect combustion. The correct distance from burner to fire pan floor is 6 in. to 9½ in., depending on the draft arrangement, and particular attention should be given to see that the burner is so placed that the oil strikes the flash wall in the center. Care must also be exercised to see that fire pan is free from air leaks with no obstruction on the floor and that all damper controls are in perfect working order.

There are two ways of drafting an oil burning engine; one, the horizontal draft and the other the vertical. Both are in general use on oil burning roads. The arrangement of the brick work on both drafts is practically the same. The horizontal draft, by which air is admitted through the fire door, is the most economical, but in poor water districts, from the standpoint of boiler maintenance, the vertical draft arrangement with the flat door, by which air passes to the rear of the firebox, prevents cold air from reaching the staybolts and thus reduces boiler maintenance. The horizontal draft in good water districts has proved very successful both from the standpoint of boiler maintenance and fuel consumption.

Air openings through the fire pan should vary, depending on the size of the firebox—from 16 sq. in. air admission around the burner and 85 sq. in. at the rear of the firebox, to 225 sq. in. around the burner and 224 sq. in. at the rear. It has been found that the best results are obtained on an oil burning engine with the use of an extension stack extending down to the center line of the boiler, 12 to 16 in. in diameter.

To secure the best results the fire pan should be welded to the mud ring and rigidly secured so as to obviate all possibility of air leaks at sides and front or behind the brick work. Too much attention cannot be given to the maintenance of fire pans on oil burning locomotives.

Front end air leaks and outside steam leaks should not be tolerated. In the roundhouse one man should be assigned to make torch tests and repair all air leaks into the front

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*Abstract of a report presented at the meeting of the Traveling Engineers' Association, at Chicago, September 8, 1921.

end and around outside steam pipes. There are many recommended practices for the elimination of air leaks around outside steam pipes. The best one in use is the application of a casing of ¼-in. steel plate with a welded seam. This casing is riveted permanently to the smoke box and then caulked or welded around the edge to make it airtight. It is large enough in diameter to allow removal of the steam pipes without disturbing it. The lower end of the casing is flanged outward and to it is riveted a wrought iron ring. A cast iron flange made in halves is fitted together and bolted snugly around the steam pipe, which is machined true at this point. This flange is secured to the wrought iron ring with eight studs and a copper wire gasket is used between them to obtain an airtight joint. A copper gasket is then caulked into a dovetail groove in the cast iron flange around the steam pipe.

Operation of oil burning locomotives call for the same attention from the engineer as on a coal burner but the fireman has no manual labor to perform in delivering fuel to firebox. But he has to be alert at all times for there is no bank of burning coal to aid him in keeping an even firebox temperature when the engineman is working a light throttle or drifting after having forced the locomotive to its capacity. A supply of clean, gritty sand should be used in the sand box of the locomotive with a sand scoop so the fireman can clean the soot from the flues. Flues should be sanded while running by placing a small quantity of sand in the scoop and by inserting through an opening in the fire door while the engine is working hard, allowing the exhaust to draw the sand through the flues. It is good practice to sand frequently in order to keep the soot removed. It is a non-conductor of heat and causes the steam pressure to drop rapidly. Enginemen should take care to give the valve sufficient travel and open the throttle far enough so that the exhaust will carry sand through the flues and do the work for which it is intended. The sand scoop should be held as far in the fire door as possible in order to prevent sand from falling on brickwork or flash wall.

Firemen should watch the temperature of oil and endeavor to keep it just warm enough to insure an even flow to the burner. This temperature will vary from 100 deg. F. for light California or Texas oil to 180 deg. for heavy Mexican oil. The fireman has direct control of the amount of steam used to heat the oil in the tender and unless he is careful he may not only damage the oil by overheating it so that it loses its lighter gases, but also increase the danger of explosions from the escaping gas. Where excessive steam is turned into the tender there is excessive condensation and unless this water is drained off it will go to the burner and often puts the fire out. Heating the oil in the tender is not for the purpose of aiding in burning it but to cause it to flow in a steady, even stream from the tender to the oil feed line, where it passes through a superheater box before it reaches the burner. The purpose of the superheater is to raise the oil to a temperature at which it will be easily broken up by the atomizer as it goes from the burner tip into the firebox. Since it takes less than one-fifth of a second for a particle of burning oil to travel from the burner tip to the flue sheet, it is of the utmost importance to have oil so atomized that no time is lost in burning it. The use of the blower is to create sufficient draft to keep the firebox clear of smoke and gases and to produce artificial draft. The misuse of the blower causes waste of fuel and damage to the boiler. Very light applications should be indulged in under all conditions. The strong use of blower draws cold air into the firebox, damaging the flues and flue sheets, and causing them to leak.

A slight color of smoke at the stack is better than no smoke at all, for a clear stack indicates too great an amount of air. Losses from too much air are frequently three times as great as from insufficient supply. Firemen should avoid black smoke at all times if possible; it indicates a loss of fuel and should not be tolerated. Black smoke is either the result of faulty firing or the condition of the engine. The firing valve by which the flow of oil to the burner is regulated requires constant attention. Lost motion frequently occurs in this apparatus. Much fuel is wasted when the fireman loses the correct adjustment of this valve because of too much play either in the rods or in the valve itself.

When an engine is worked to full capacity on long grades and has been fired heavily it requires very careful attention to prevent flues from leaking as the small tongue of flame does not fill firebox sufficiently to keep out the cold air. Enginemen cannot be too careful at such times; they should start gradually to ease off on the throttle, allowing the fireman plenty of time to adjust his firing valve. Injectors should be shut off at once, if only for a short time, and then worked at short intervals. In most cases engines start leaking while descending grades after having been worked hard. Careful team-work between engineer and fireman will prevent black smoke when shutting off or pulling out of stations.

The report was signed by J. N. Clark (Chairman), Sou. Pac. Co.; J. C. Harris, G. H. & S. A.; H. H. Kane, Gulf Coast Lines; E. F. Boyle; E. E. Cornish, M. K. & T., and W. G. Tawse, Locomotive Superheater Company.

Discussion

In answer to a number of questions relative to the terminal handling of oil burning locomotives, J. N. Clark (Southern Pacific) stated in closing that from 50 gallons to 175 gallons of oil are required to fire up engines at terminals, requiring from 30 min. to 1 hr. 50 min. before leaving time. A test made with a 2-8-2 type locomotive weighing 207,000 lb. on drivers, was fired up with ⅓ glass of water at 120 deg. in a total time of 108 min. to 200 lb. gage pressure, with a consumption of 119 gallons of oil. In comparison with 15 per cent to 25 per cent of the fuel consumed at terminals on an eastern coal burning road, the terminal oil consumption was estimated at about 8 per cent of the total fuel.

Mr. Clark referred to a test made under the supervision of the fuel conservation committee of the Southern Pacific in which the fuel consumption per 1000 ton-miles was measured for a 1,000-ton train hauled by a 2-10-2 type superheated locomotive. At 5 miles an hour the oil consumption was .3 gal.; at 10 miles an hour, 1.1 gal.; at 15 miles an hour, 2.5 gal.; at 20 miles an hour, 4.5 gal.; at 25 miles an hour, 7 gal.; at 30 miles an hour, 10 gal.; at 35 miles an hour, 13.7 gal.; at 40 miles an hour, 18 gal.; at 45 miles an hour, 22.7 gal., and at 50 miles an hour, 28 gal. A test to show stand-by fuel consumption showed that 45 gal. of oil per hour was refined to hold train and run the air pump, while 37 gal. an hour was burned by a light engine standing under steam.

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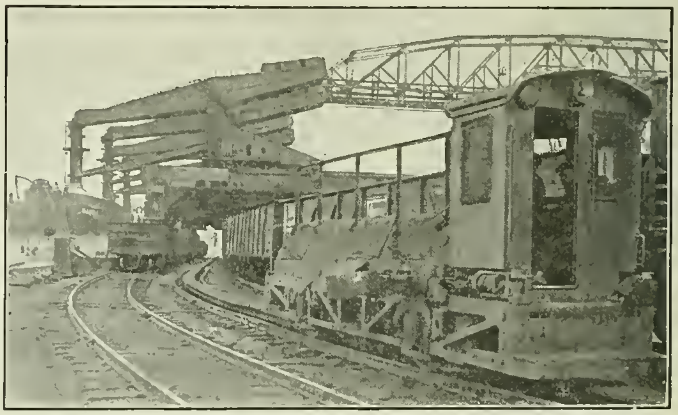


Photo by Ewing Galloway

Ore Docks on the Lake Front at Cleveland

Locomotive Weighing Plant of Large Capacity

Heavy Scale Is Housed in a Special Building with Equipment for Determining All Wheel Loads at One Time

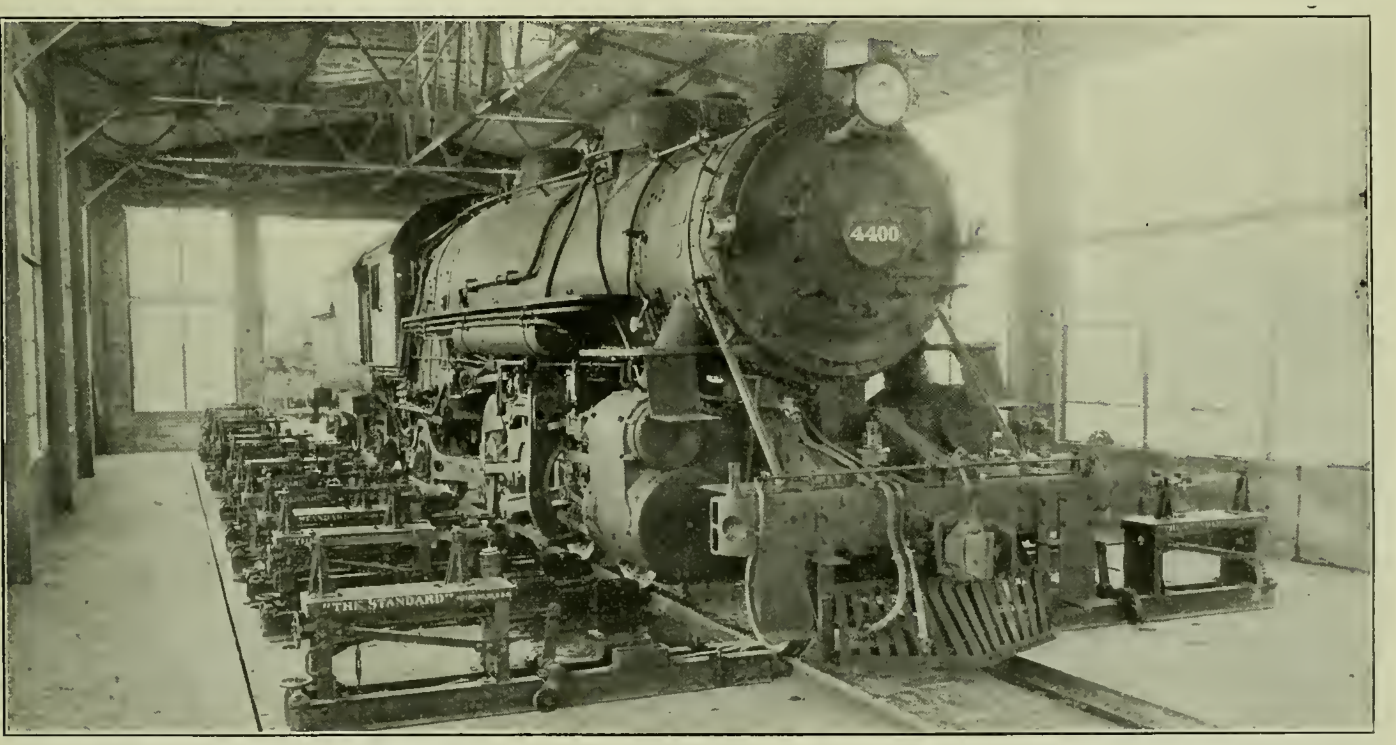
BY CARL C. BAILEY
Baldwin Locomotive Works, Philadelphia, Pa.

A LOCOMOTIVE weighing plant was recently completed at the Eddystone plant of the Baldwin Locomotive Works, which is unsurpassed in size and novelty of construction. It is comprised of a platform track scale, 24 individual wheel scales, concrete foundations of massive construction, and a specially designed building which covers and protects the scale and its mechanism. The large scale is composed of six-sections, and is designed for a total working capacity of 450 tons.

The Baldwin Locomotive Works heretofore determined the total weight of the locomotive on a track scale, after which the individual wheel loads were obtained by moving the locomotive to a specially constructed track having concrete foundations of sufficient width to allow the placing of individual scales under each wheel. With this method of weighing, it was difficult to obtain any degree of accuracy when comparing the weight on the platform with the total weights on the individual scales.

After investigations relative to the assumed loading of the largest locomotive which it would be practical to build, it was decided to construct a scale having a working capacity, as previously mentioned, of 450 tons, with a platform of sufficient width to permit the use of individual scales under each wheel. A scale of this type would give accurate results and all weights would be determined with the engine in one location.

In designing the scale the stresses as recommended by the specifications of the American Railway Association, as well as those of the United States Bureau of Standards, were taken into consideration. However, the necessity for rigid limitations on deflection in the longer extension levers, resulted in designs which in many instances give unit stresses very much below specification limits. To conform to these specifications, the designers were confronted with the question of producing a knife edge in the main levers of sufficient length to give a unit loading not to exceed 7,000 lb. per lineal inch, and also with the problem of supporting it in a substantial manner to secure an even distribution of the load. These knife edges are 22 in. long and are made of a special alloy steel which, when hardened in oil, has an elastic limit of not less than 160,000 lb., and a tensile strength of not less than 200,000 lb. per sq. in. The entire surface of all pivots and bearings throughout the scale is machined, hardened and ground and set in machined ways. All bearing steels for fulcrum stands are set in removable blocks that may be lifted off the stands. These knife edges are so constructed as to have continuous contact with their bearings and there are no bow loops in this scale except those for counter-balancing or back-balancing the weigh beam.



A Locomotive on the Scales with the Portable Wheel Scales in Position

There are 12 cast steel main levers weighing approximately 1,075 lb. each. They rest upon fulcrum stands at one end and are suspended by a stirrup 2¼ in. in diameter at the other. From these the massive cast steel yokes that carry the platform are suspended by two heavy machine steel stirrups 3 ft. long and 2¾ in. in diameter.

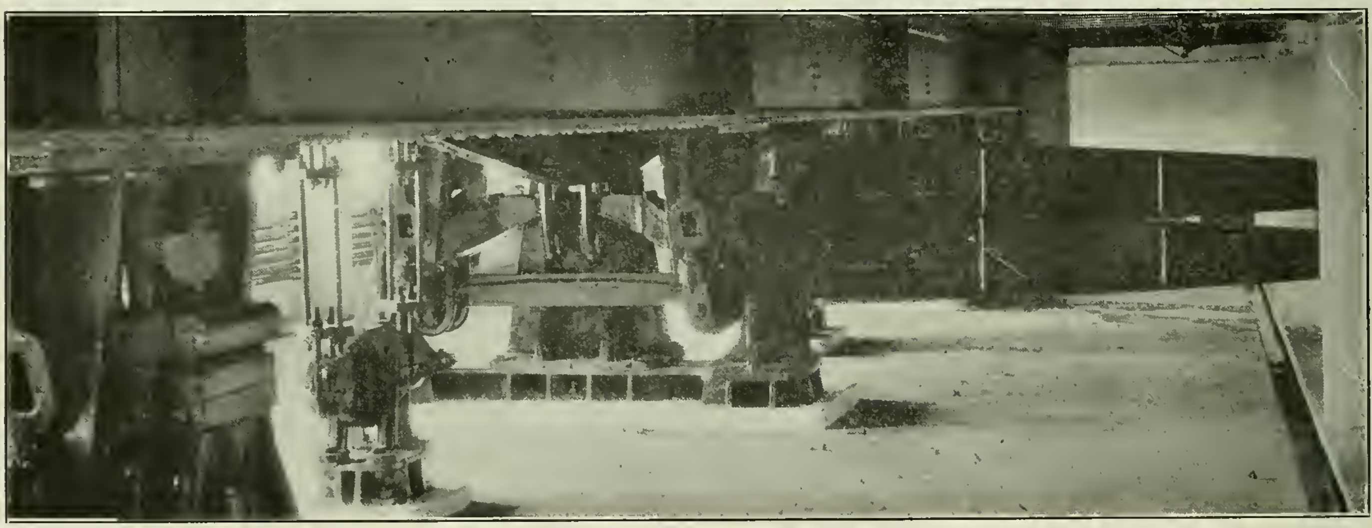
The connection between the middle extension lever and the tranverse extension is accomplished by means of two machine steel stirrups 1½ in. in diameter that pass over bearing blocks which engage the butt pivot of the tranverse lever and the end pivot of the middle extension lever. These stirrups are then connected by a 2-in. plate which permits vertical adjustment.

The connection between the middle extension lever and the 3-ft. even lever consists of two machine steel stirrups of 1⅛-in. diameter that pass over the bearing blocks which engage the end pivot of the middle extension lever and end pivot of the even lever. These stirrups are connected by means of two 1½-in. plates and two draw bars 1⅛ in. in diameter. At the fulcrums of both the even and the extension levers, there is an up-pull. These fulcrums are anchored to the sub-bases by means of two cast steel anchors in the form of an inverted stirrup, one at each side of the lever. Each stirrup is held down by two 1¼-in. anchor bolts.

The connection between the transverse extension lever and the lever under the weigh beam is composed of stirrups, plates, draw bars and bearing blocks, all so arranged that one lever may be leveled independent of the other, that proper swiveling can take place to match the different angles at which the levers hang, and to give vertical adjustment to the levers in unison.

The weigh beam on the platform scale is graduated to 895,000-lb. capacity by 5,000 lb., with an auxiliary beam of 5,000-lb. capacity by 50 lb., giving a total capacity of 900,000 lb. This weigh beam is of "The Standard" type with a pin recording attachment. The main weigh beam, as well as those of the individual scales, is made of high grade cast iron, fitted with steel inserts for the notches.

The main girders that form the weigh bridge for the platform are constructed of 30-in. 200-lb. Bethlehem girder beams with ¾-in. plates riveted on the top and bottom to increase the section modulus. These girders carry 12-in., 28.5-lb. I-beams placed transversely to form the platform. (It is on this platform that the individual scales are placed to obtain the wheel loads.) The deck is composed of a ½-in. steel plate riveted to the I-beams.



View of the Scale Mechanism on the Lower Level

The suspension pendulums that carry the weigh bridge upon the lever system are adjustable. The bearing and rocker blocks are made of steel castings and distribute the load uniformly over the entire knife edges.

Individual Wheel Scales

The individual wheel scales were designed and constructed more substantially than the ones previously used in obtaining individual wheel weights. The entire frame work, with the exception of the levers, knife edges, bearing blocks, and a few minor parts, is of structural steel.

Each individual scale, although weighing 2,310 lb., can be moved about easily on two rollers or wheels which can be lowered or raised clear of the floor by means of a lever and screw device. These wheels run on roller bearings and enable the scales to be handled with remarkable rapidity.

Each individual scale is so placed that one knife edge is directly under a wheel of the locomotive. Over this knife edge there is a small bearing block which is placed under the tread of the wheel by planing off one side of the rail head flush with the web. This bearing block distributes the load over a knife edge of sufficient length to limit the lineal pressure under full load to 7,000 lb. per in.

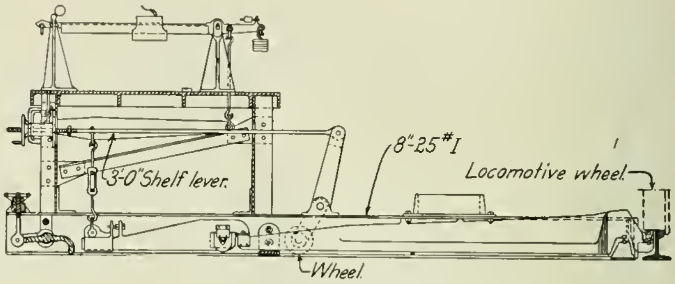
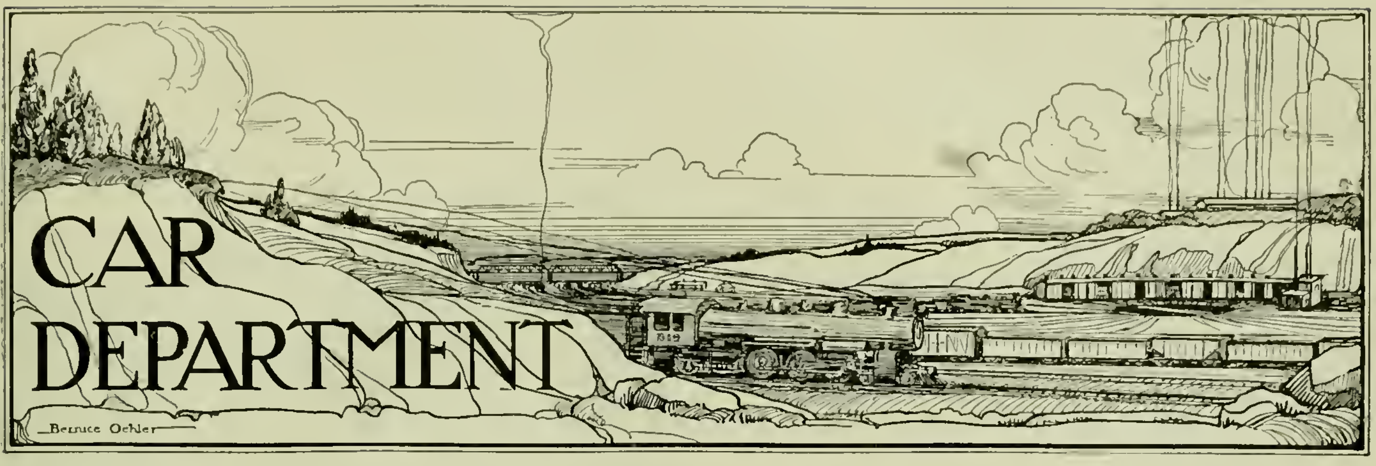


Diagram of the Individual Wheel Scale

The locomotive wheel must be raised clear of the track before the weight can be registered on the weigh beam. To accomplish this, jacks which are raised and lowered by means of ratchets, have been placed on each side of the 8-in. I-beams which form the frame work for the scale. In order that the individual scales may be in alinement at all times, a small level has been placed on the shelf directly under the weigh beam. The capacity of an individual scale is 49,000 lb., increased by an additional 1,000 lb. by 10 lb. on an auxiliary beam, thus giving a total weighing capacity of 50,000 lb. An idea of the accuracy of the wheel scales was obtained in recent tests in which the sum of the wheel loads obtained with the individual scales varied only one-half per cent from the total weight recorded by the platform scales.

The equipment is housed in a building of hollow tile and steel construction, 122 ft. long by 42 ft. wide. The foundations are of concrete, with a concrete mat 110 ft. long, 11 ft. wide and 3 ft. deep, reinforced with 100 lb. rail. In this mat were placed 15-in. 42-lb. I-beams to which the foundation bolts were anchored.

Designs for the scale and the installation of the equipment were worked out and built under the direction of W. N. Haines and D. L. Daly of the Standard Scale & Supply Co., Pittsburgh, Pa., and B. T. Converse and the writer, of the Baldwin Locomotive Works.



Repairing Steel Cars in a Remodeled Roundhouse

N. Y., N. H. & H. Secures Efficient Repair Plant with Small Expenditure for Facilities

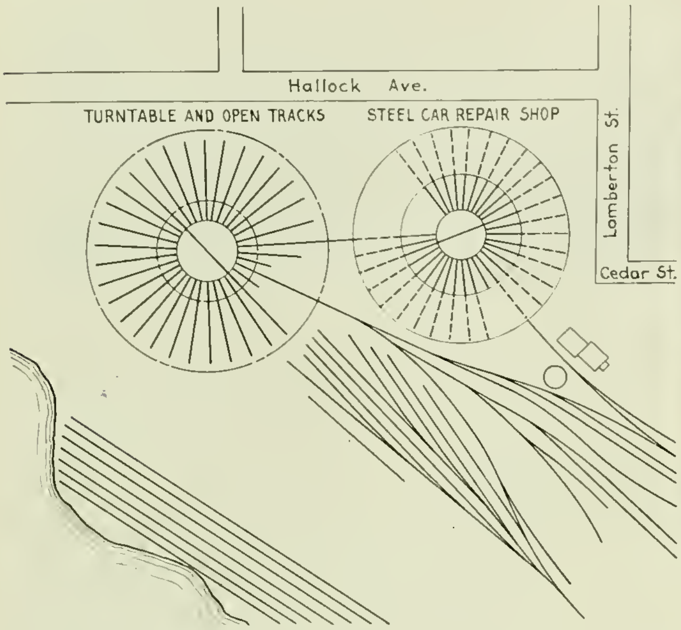
DURING the past year, probably more than ever before, the officers of the railroads have been confronted with the difficult problem of improving the economy of operation with a very meagre expenditure for new equipment. In many cases it has required a high degree of resourcefulness to transform unsuitable facilities into efficient shops, but it is just such measures that enabled the roads to move the heavy traffic of last fall and that will make it possible to reduce the accumulation of bad order cars as they are once again required for service. There have been many emergency shops fitted out during the past year that have given more or less satisfactory results. The purpose of this article is to describe a plant that was pressed into service by the New Haven for repairing cars, which, by careful attention to details, was brought to a standard of efficiency that compares favorably with many shops built expressly for that purpose.

At the termination of federal control, the New York, New Haven and Hartford, in common with practically all other roads, received from connections a great many cars that had been off the home line for a long time and needed extensive repairs. This situation made it necessary to provide additional shop facilities at New Haven, especially for repairing steel cars. A short time previous the road had placed in operation the new Cedar Hill freight terminal. As a result the Lamberton Street roundhouse, adjacent to the passenger terminal and shops, was no longer in use. It was decided, therefore, to equip the roundhouse for repairing steel cars.

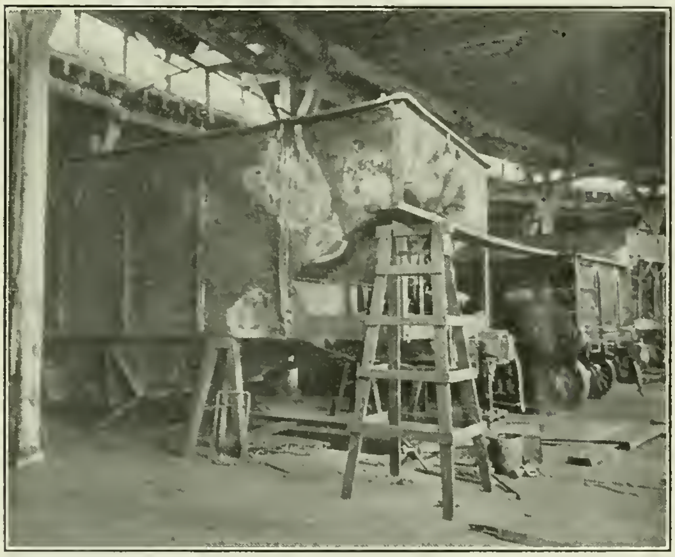
A General View of the Machine Department

The layout of the roundhouse and adjacent tracks is shown in the drawing. It will be noted that the roundhouse consists of a full circle, 29 pits with two tracks leading to the turntable. One of these tracks leads directly to the yard, while the other goes to an outside turntable serving open storage tracks and having a separate track to the yard.

The roundhouse itself is a substantial structure with brick walls and wooden columns and roof timbers. Both the inside and outside walls had a reasonably large window area and additional natural light was furnished by a monitor in the roof. In order to make the building more suitable for repair work, the interior was first whitewashed and the pits were boarded over. Electric lights were installed on the columns and steam heating pipes were placed on the outer wall. Compressed air lines were also run around the outer wall and outlets were brought to the columns between the pits. A connection was made to the air supply main from the power house and a compressor and boilers were also installed adjacent to the inner wall to insure an ample supply of air. Fuel oil piping was also installed. This is connected direct to stationary rivet heaters located at convenient points in the house and in addition supplies oil for eight portable heaters. As it was planned to utilize oxy-acetylene torches to a large extent, especially for dismantling the cars, both these gases were piped throughout the shop.

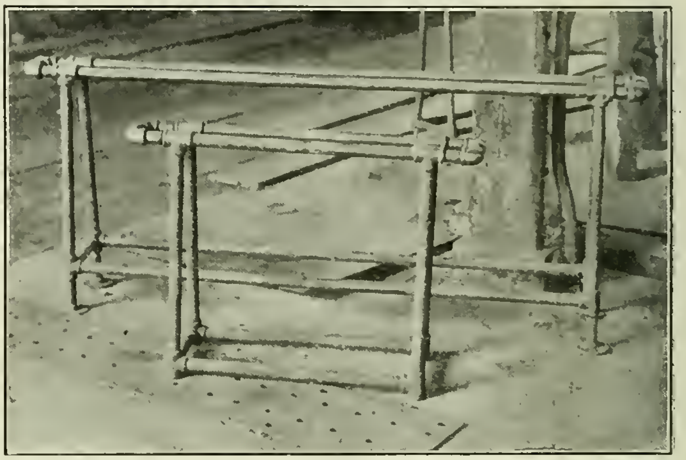


Arrangement of Tracks Serving the Car Shop

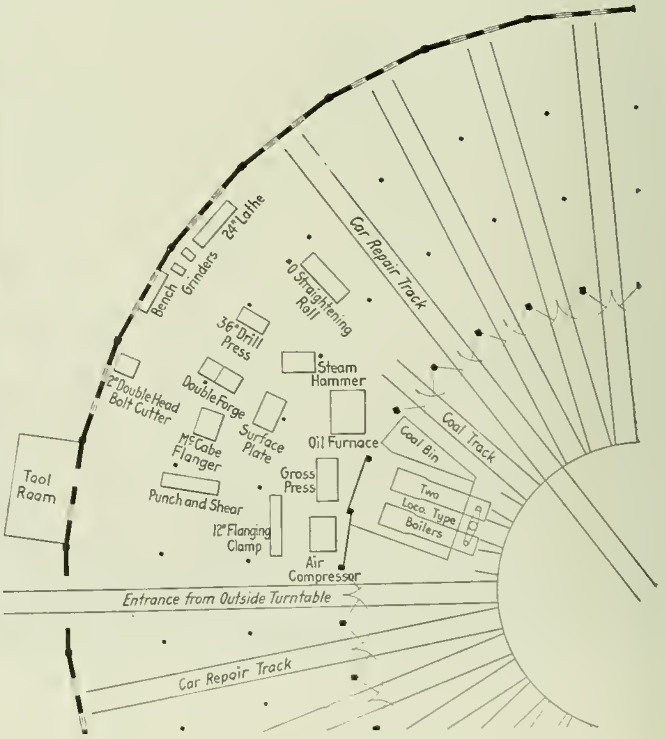


The Spacing of Tracks Provides Ample Room Even at the Inside Wall of the Shop

Local conditions made it most convenient to bring the cars into the house over the outside turntable and the general method of operation was planned with this in mind. On one side of the incoming track a space of four pits was arranged for the shop machinery. On the opposite side of the track seven pits were set aside for stripping. The remainder of the tracks are used for assembling the cars. The larger material used in the shop, such as pressed sheets, side stakes, etc., is stored between the shop and the open turntable and one of the tracks has a platform, reached by a ramp, from which scrap can be loaded directly into a scrap car.

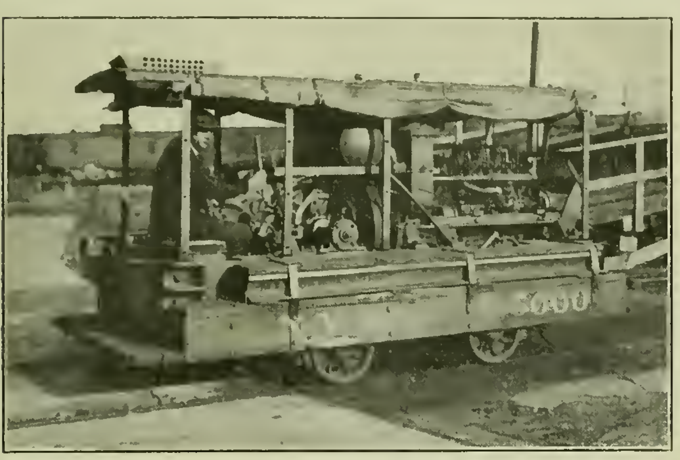


Horses Made of Pipe Combine Lightness and Strength



Layout of Machine Tools

The tools provided in the shop were selected for their adaptability in handling the wide range of work that is met in making heavy repairs to steel cars. All the large pressed steel parts standard to New Haven cars are bought from car builders and a majority of the other parts are received ready for application, so no tools for quantity production are needed. Many of the smaller steel parts are made on the McCabe flanger or on a 12 ft. pneumatic clamp. Straightening is done by means of a 15 ton Gross press or on a face plate. For heating sheets or structural shapes, an 8 ft. by 12 ft. oil furnace is provided. Other equipment includes a 1,200 lb. steam hammer, a 48 in. punch and shear, two hooded forges and one large open forge, a 36 in. drill press, a lathe, bolt threader and wet and dry grinders.



Gasoline Tractor Used for Switching Cars Around the Shop

The seven tracks on the opposite side of the incoming track comprising the stripping department, are especially equipped for this work. Air jacks mounted on wheels are provided for raising the cars and a 1,200 lb. air hoist for handling the sheets is mounted on a runway above the center line of each track. On these tracks the cars are cut down with the oxy-acetylene torch. The parts to be discarded are picked up by an electric load-carrying truck with a jib crane and are carried directly to the scrap car. As the old material is removed the new sheets are brought in by truck and are set on horses at the end of the car. When the stripping is finished the new parts are picked up by the air hoist and loaded onto the car, which is then switched across the turntable by a gasoline tractor and placed on one of the tracks where the assembling is done.

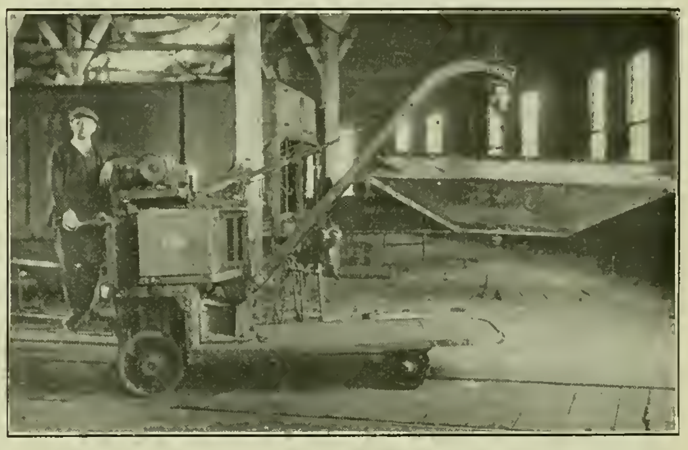
Stationary Rivet Heaters Installed in the Assembling Department

The practice of stripping on separate tracks and loading material onto the car before it goes to the assembling department has several advantages. It shortens the haul for the electric trucks, provides a loaded movement in both directions and keeps the assembling department clear of scrap and refuse from the dismantled cars.

The tractor used for hauling cars around the shop is so unusual that it merits special mention. It is driven by a four-cylinder gasoline engine through a variable speed friction drive. The short wheel base makes it convenient for handling cars on the turntable. By weighting the tractor down with rails the adhesion has been increased so that it is now capable of handling as many as five cars at a time.

After the cars are switched to the assembling tracks, they are raised by air jacks, the bodies are placed on horses and the trucks are run out at the ends of the car, where they are overhauled. The method of assembling the bodies differs little from general practice. All riveting is done by air hammers as a power riveter to handle the work would necessarily have a very large gap and no facilities are available for handling it.

The results obtained from the operation of the shop have been extremely satisfactory. It may be said in general that the important factors in successfully transforming the roundhouse into a steel car repair plant were careful planning of the operations and the provision of equipment which, though not elaborate, facilitates the work, eliminates unproductive movements and avoids the condition so often found where the shop output depends primarily on the physical exertion of the employees.



Electric Truck with Jib Crane Facilitates Material Handling

Supplying Additional Information on Billing Repair Card

New instructions permitting the correction of billing repair cards in case information given on the original record of repairs has been omitted, have recently been issued by the Arbitration Committee of the Mechanical Division of the A. R. A. in circular D. V.—218. The full text of the circular is as follows:

The Arbitration Committee has had a number of questions recently relative to billing repair cards returned with exceptions, where the repairing line has supplied additional information on the repair card.

There are old arbitration decisions which prohibit the practice of supplying additional information on billing repair card and restrict the charge of the repairing road to the least expensive material or second hand material where the billing repair card did not originally show the kind of material applied.

When these decisions were rendered, the billing repair card was also the original record of repairs, being prepared at car, one copy being attached to car, one copy used for file and the original used for billing.

Since the practice of attaching billing repair cards to cars has been discontinued (except in the case of certain private owned cars) and a form of original record of repairs has been adopted, as covered in Interchange Rule No. 7, the Arbitration Decisions referred to are abrogated.

In cases where, through oversight of clerks, the billing repair card is incomplete, correct reference may be supplied provided the original record of repairs is clear as to repairs made and material used. The original record will be subject to review by the car owner in case of dispute.

Billing repair cards should show actual conditions and check with the original record of repairs insofar as they should check.

Clerks preparing billing repair cards should not assume any information required by the Rules of Interchange which is not clearly shown on the original record of repairs.

Suggestions for Passenger Car Design

BY GEORGE S. CLOUSER

The present designs of railroad passenger cars seem to be objectionable from the standpoint of economy. This applies to more than the high first cost; they are objectionable on account of the lack of comfort that is often to be observed in the heaviest and presumably most costly of our cars. With the present trend toward lower prices, it is idle for the railroad managements to say that the demand is constantly for more and more costly service; if an earnest attempt were made to provide less costly service that had the prime requisite of railroad service; i. e., getting the people there when they want to go, and, if rates were brought down, the traveling public would be better satisfied.

A mistake made by one of our eastern roads that caused it to lose passenger traffic is to have the seats in its passenger cars too near together. This seems to be a very small matter, but it is sufficient to deter many people from traveling on this road. The cars are otherwise very nice; they look good both inside and out, they are well heated, the windows open wide, they are kept clean, the trains run fast, but the seats are too near together. This road is not saving any money by the close spacing of seats. If the cars were light in weight, one might assume it was done to economize. Actually the weight per passenger is very high.

Another mistake made is in not providing enough standing room. Nowhere in the settled parts of the country are the passenger trains able always to take care of the people that offer themselves for passage and give them all a seat. The ordinary day coach takes no cognizance of this fact, it is made to sit down in and the people who stand are utterly neglected. The present aisles are too narrow in relation to the rest of the car; the windows are set too low, and there is nothing to hold on to. For this reason the people crowd the platforms as soon as the seats are full so that the total capacity of a day coach seating 80 people is only about 100, or about the same as a trolley car of half the seating capacity. The way to remedy this condition is either to always have enough cars to handle the crowd, or provide standing room.

For short haul travel the arm rests at the aisle side of the seat might as well be omitted. The space saved by cutting down the width of the seats would, of course, go into extra aisle width, and the extra aisle width means more standing room. The question of handholds requires some consideration. Straps might do in the case of suburban traffic, but grab handles on the edge of the seat-back seem more desirable.

At the ends of passenger coaches there is usually a separate compartment seating four people. If the wall between it and the rest of the car were omitted, the car would be more roomy. To carry this particular argument to its extreme conclusion, leaving out the wall between the vestibule and the rest of the car, as far as possible, would be to still more advantage. At the same time a door should be provided at the end of the vestibule. With the maximum of clear space provided in this manner the cars would look much roomier, would have a much greater maximum capacity, and would empty and fill rather more quickly.

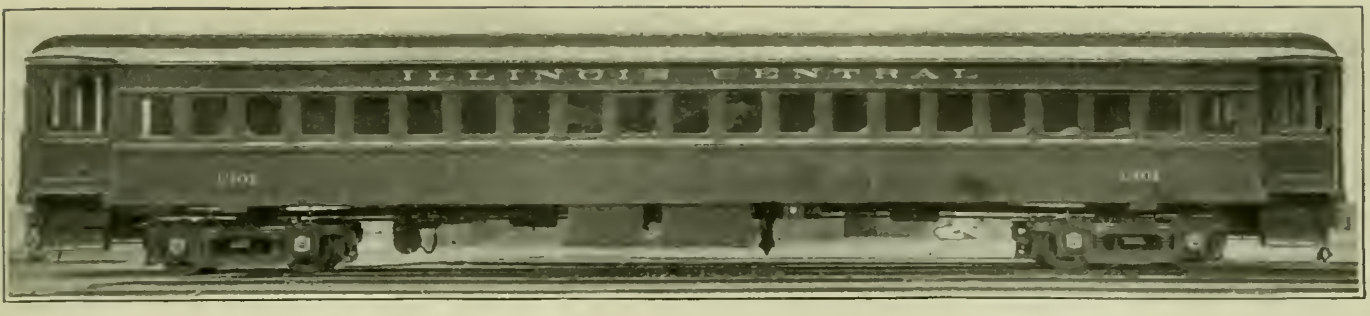
There are usually several seats at the ends of each car that have vertical backs instead of the inclined backs that are applied to the other seats in the car. Each of these seats is a cause for dissatisfaction. It should be worth while to consider giving these seat backs the same slope as the others, adding a little to the distance between uprights at these points if needed. Many of our railroads have cars with windows that open only part way. These windows are very inconvenient. They make the cars hot and stuffy and it is difficult to get a good view of the scenery. Even the Pullman company does not make all the provision it should for the comfort of passengers. With the general aspect of luxury in the cars it is remarkable that the parlor cars are not comfortable, except for a person below the average height. The seats are too straight backed and are not high enough from the floor. I make no comment on sleepers; that ground has been often covered.

For suburban service another method of increasing capacity presents itself, which is to make the seats just a little wider and to seat three. By saving on the thickness of the walls and leaving off the arm rests, this might be done on both sides, increasing the seating capacity by 50 per cent. By just taking a little off one side and adding it to the other, the seats on the one side could be made to seat three, an increase of 25 per cent, which would make eight cars do what ten cars did before.

As has been pointed out in the *Railway Mechanical Engineer,* the present designs of railroad cars seem too heavy for the service rendered. The street railroad people woke up to the same condition in their business many years ago. They figured that it cost them $50 a year to carry a ton of car around the streets and have since made considerable efforts to make one ton do what two tons did before. The steam railroads might well profit by their example. A general lightening all over seems possible.

In the earlier days of the car lighting art, when only a few cars were electric lighted, it was necessary to equip cars with storage batteries, the only alternative being to keep electric lighted cars segregated and run them in solid trains. Now that a great proportion are so lighted, the time has come when the storage battery and the axle generator may be eliminated, and the cars wired to take current from the engine. All locomotives are equipped today with generators and it would be no great trouble to equip the terminals with wiring so that cars could be lighted while waiting for engines. The generator needed for lighting a train would probably deliver the light for no greater expenditure of fuel than the present round-about way through the main engine, axle generator and storage battery, or even the direct method of storage batteries alone. Certainly the investment would be less, also the upkeep, and there would be a considerable decrease in the total weight to be carried around with a corresponding decrease in cost. Such train lighting equipment is already on the market. If the managements could get together and agree on standard voltage and couplings, the cars would be interchangeable the country over.

For many years the statement has been made that the public demands ever more and more costly service. Today the public demands cheaper service. In the past the railroads have added heavier and heavier cars to their trains without a corresponding increase in capacity, with the result that heavier and heavier engines are needed. By judicious design of passenger cars, it should be possible to cut down many of the items of expense that enter into the total cost of transportation, and even to speed up some of the trains in place of the lengthening of the running time that we have seen take place so often in the last few years.



Illinois Central Suburban Cars, Adapted for Electric Operation

Illinois Central Steel Suburban Coaches

Designed for Future Electrification; Doors Electrically Controlled; Total Weight 92,100 lb.

THE Illinois Central has recently received from the Pullman Company 20 new steel suburban coaches, which have been placed in service in Chicago, the design of which has been influenced in numerous details by the prospective electrification of this road within the Chicago terminal district. The cars are completely equipped for steam train service, in which they are now operating, and have been designed primarily for trailer service after electrification has been completed, although the car bodies are of sufficient strength to be equipped with motor trucks, and other electrical apparatus, should this later seem desirable. The weight of the cars equipped for steam operation is about 92,100 lb.

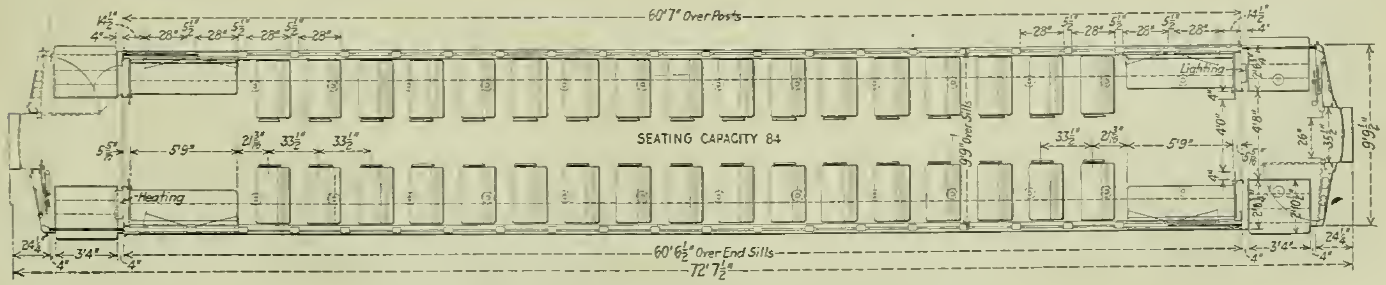
Interior View, Showing Open-End Seats

At present the cars are equipped with steam heat and with axle generator and battery equipment for electric lighting; this equipment in both cases follows the standard of the road for passenger coaches in main line service. The conversion for electric service will consist of the substitution of electric heaters for the present steam heat equipment and the removal of the axle generator equipment, the current for lighting then being obtained from the power source. The vestibules have been arranged to facilitate the installation of multiple unit control apparatus, brake valve, gages, etc., and with this in view the hand brake staff and handle have been placed on the left side instead of the right side of the vestibule platform.

The cars have a coupled length overall of 72 ft. 2 in. and are 60 ft. 6½ in. long over the body end sills. A seating capacity of 84 is provided for by 17 transverse seats on either side of the car and four longitudinal seats 4 ft. 9 in. long, one on either side at each end of the car. Sliding doors are used throughout. Those at the ends of the seating compartment close from either side toward the center, while the end and side vestibule doors are each single units, the former opening toward the left while the latter slide back into the side walls of the car body. The end doors of the car and the vestibule side doors provide a clear opening of 4 ft. in each case, while the vestibule trap doors are 3 ft. 4 in. in width. The floor plan shows the proposed arrangement of the control apparatus for electric operation and the way in which the right side of the vestibule will be closed off to form the motorman's compartment.

In working out the seating arrangement, particular attention has been given to provide ample room between the seats and ample height of back for the comfort of passengers. No ends are provided on the seats, in order that the passengers may enter quickly and leave them quickly and conveniently. The width of the aisle at the seat end is about 31 in., increasing to 36 in. at the edges of the seat backs. This width is considered ample to permit two persons moving in opposite directions to pass in the aisle without difficulty.

The interior finish is steel throughout, with the exception



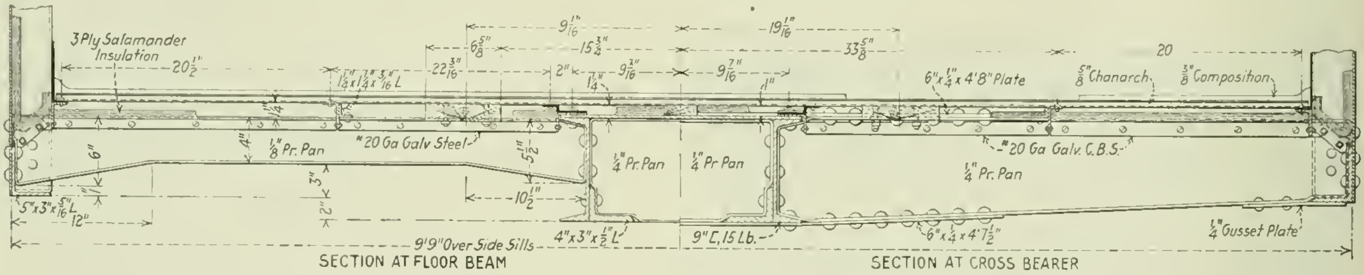
Floor Plan, Showing Provision for Motorman's Compartment of the single sash, which are of mahogany. Above the side lights the finish is in white, including the fixtures. The sides and the seat ends are finished in mahogany color.

Details of Construction

With the exception of the longitudinal sills and a few details of the vestibule ceiling construction, the frame members are practically all of pressed steel.

The center sills are 9-in., 15-lb. channels placed back to back 16 in. apart. At the bottom they are reinforced with 4-in. by 3-in. by ½-in. angles, the long flanges of which project toward the center of the car. These sills are 69 ft. 3 in. long and at the ends are framed into steel buffer castings. At the top they are reinforced with a ¼-in. plate 21 in. wide and 64 ft. 8½ in. long. Bottom cover plates of the same dimensions, each 8 ft. ⅝ in. long, extend towards the ends of the car from points about 2 ft. 6 in. inside of the center line of the body bolster.

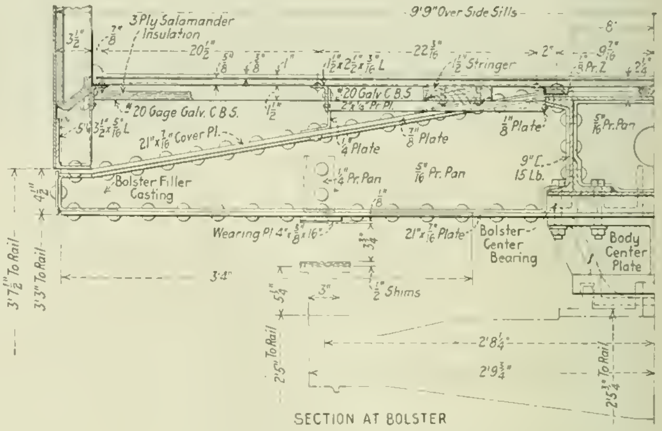
The lateral members of the underframe are all pressed steel pan sections. The bolster is formed of two of these sections of 5/16-in. material with flanges 3 in. deep, spaced 10 in. back to back with fillers between the center sills. They are finished with top and bottom cover plates of 7/16-in. material, 21 in. in width, which extend continuously from side sill to side sill. A filler casting below the center sills brings the lower face of the bolster 2½ in. below the bottom of the sills. The lower face of the bolster is horizontal while the top tapers from a depth 12 3/16 in. over the center sills to a depth of 4½ in. at the sides of the car. This brings the ends of the bolsters directly under the ⅝-in. by 3½-in. side sills.



Transverse Sections of Underframe at Floor Beam and Cross Bearer

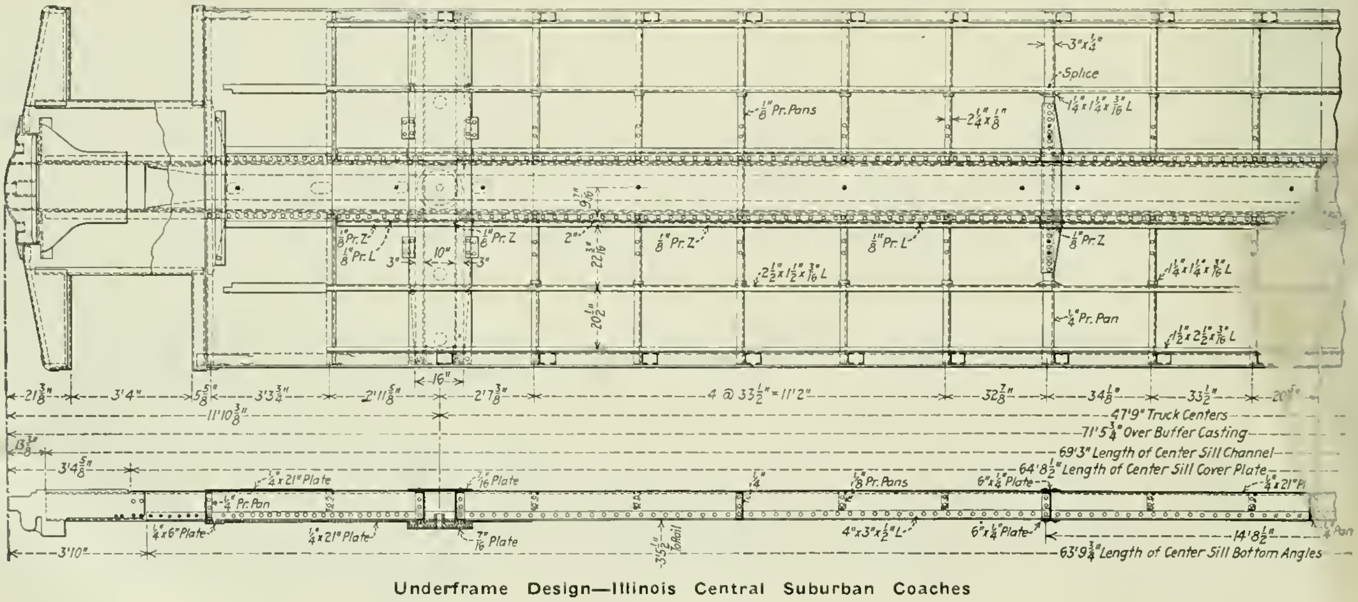
There are two cross bearers, each 7 ft. 4½ in. from the transverse center line of the car. These are each made up of three single pressings of ¼-in. material, one on either side of and one between the center sills. The three units are joined with ¼-in. top and bottom tie plates about 48 in. long. The floor beams, one of which is provided at each vertical frame member, are of ⅛-in. material.

Longitudinal stringers of 2½-in. by 1½-in. by 3/16-in. angle section are placed over the floor beams, one on each side of the car 33⅝ in. from the center line. The rectangular openings between the longitudinal and transverse members are closed with flanged sheets of No. 20 galvanized steel, painted, the flanges of which are secured to the frame members with ¼-in. stove bolts. At the sides these sheets are bolted to the vertical flanges of 2½-in. by 1½-in. by 3/16-in. angle floor supports riveted to the inside faces of the side posts.



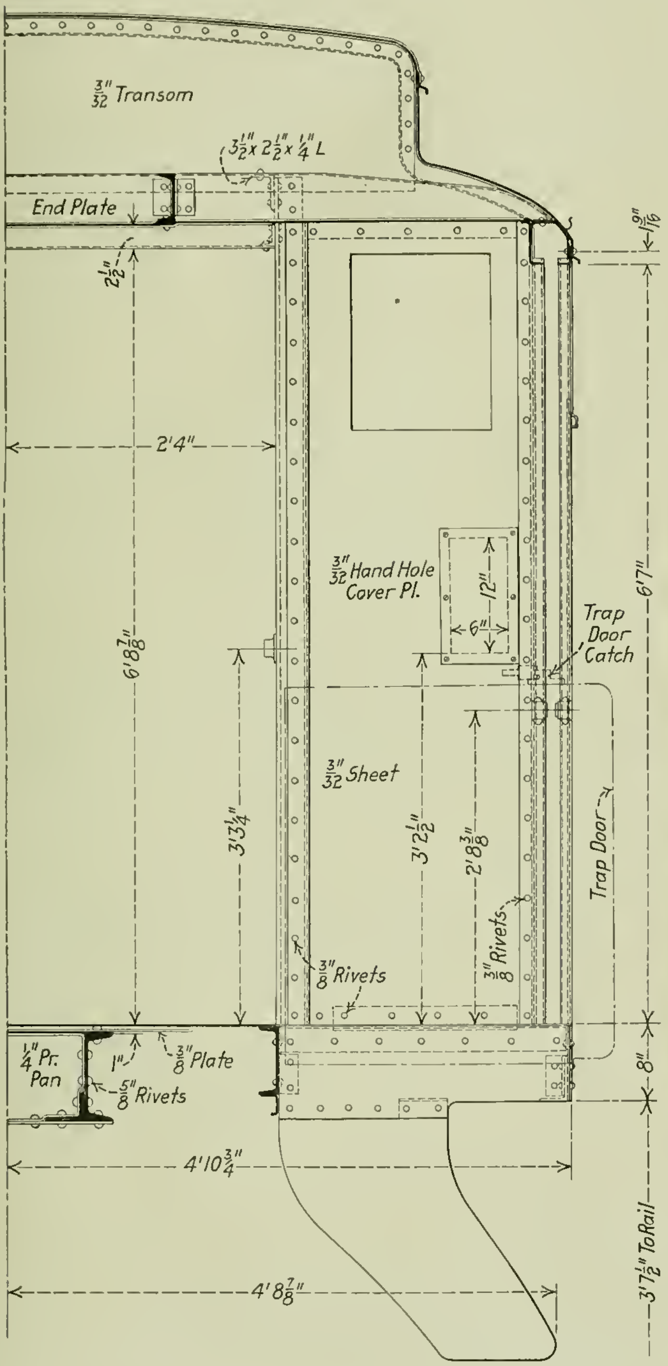
Underframe Section at Bolster

The vertical members of the side frame are double channel sections arranged to form posts 5½ in. deep by 3½ in. in transverse width. These posts are framed into the angle side



Underframe Design—Illinois Central Suburban Coaches sills at the bottom and into side plates of special pressed section at the top. The carlines are of flanged channel section, the ends resting directly on the side plates.

The outside of the car is finished with 1/8-in. girder plates and a 4-in. by 1/2-in. belt rail below the windows. The pressed steel sash rests of 1/8-in. material are placed between the side posts, which are located 2 ft. 9 1/2 in. between centers. The sash rests are 29 3/4 in. above the floor and are formed so that the outer flanges are flush with the outside girder plates. The belt rail forms a splice for the sash rests and the side girder plate. Above the windows the sides of the car are closed on the outside by a letter board about 18 in. in width.

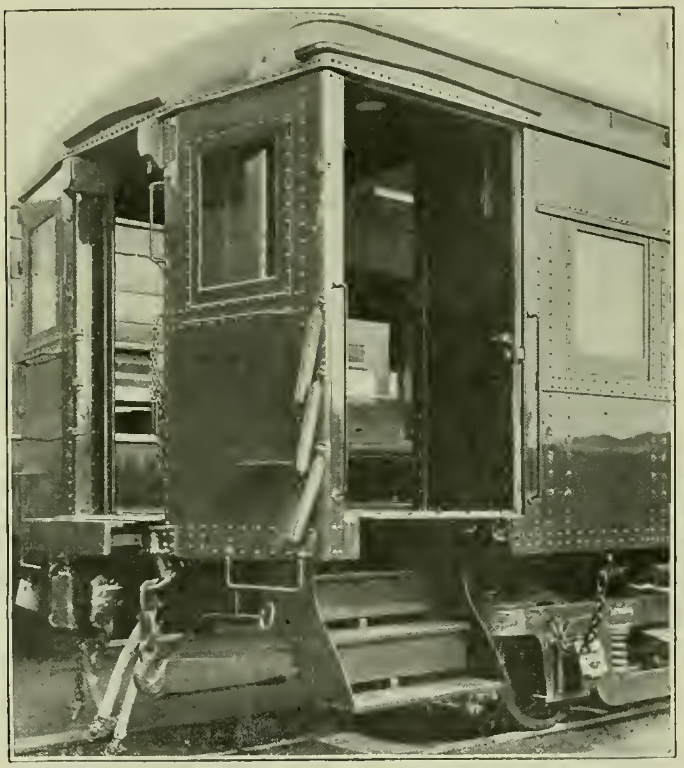


Details of Vestibule Framing of Illinois Central Steel Suburban Coaches

The principal members of the vestibule construction are 6-in. channel vestibule end posts of 1/2-in. pressed steel, 4-in. channel body door posts of the same material and body end posts of 5-in., 6.7-lb. channel section secured to the inside of the side construction. The lower ends of the vestibule end posts are framed into the steel buffer casting and at the top are secured to the ends of 5-in., 6.7-lb. channels extending longitudinally just above the vestibule ceiling to the bulkhead at the end of the car body. These channels are spaced 17 3/4 in. on either side of the longitudinal center line of the car while the faces of the body door posts are 2 ft. 4 in. on either side of the center line. The inner ends of the longitudinal channels and the upper ends of the body door posts are secured by corner plates to a transverse member of pressed steel which in effect forms a deep box girder across the car at this point. Other details of the vestibule construction are shown on one of the drawings and the photograph below.

The car body is insulated with three-ply insulation throughout, laid against the outside of the body walls. The floor is finished with 3/8 in. of composition material laid on corrugated pressed steel supports.

The cars are carried on four wheel trucks with cast steel frames and the usual type of equalizing arrangement, fitted with 33-in. rolled steel wheels mounted on axles with 5-in. by 9-in. journals. The pedestals are cast integral with the truck frames. The bolsters are of cast steel and are fitted with roller side bearings and separate center plates, the interior surfaces of which are finished and fitted with finished bronze liners. The trucks have clasp brakes.



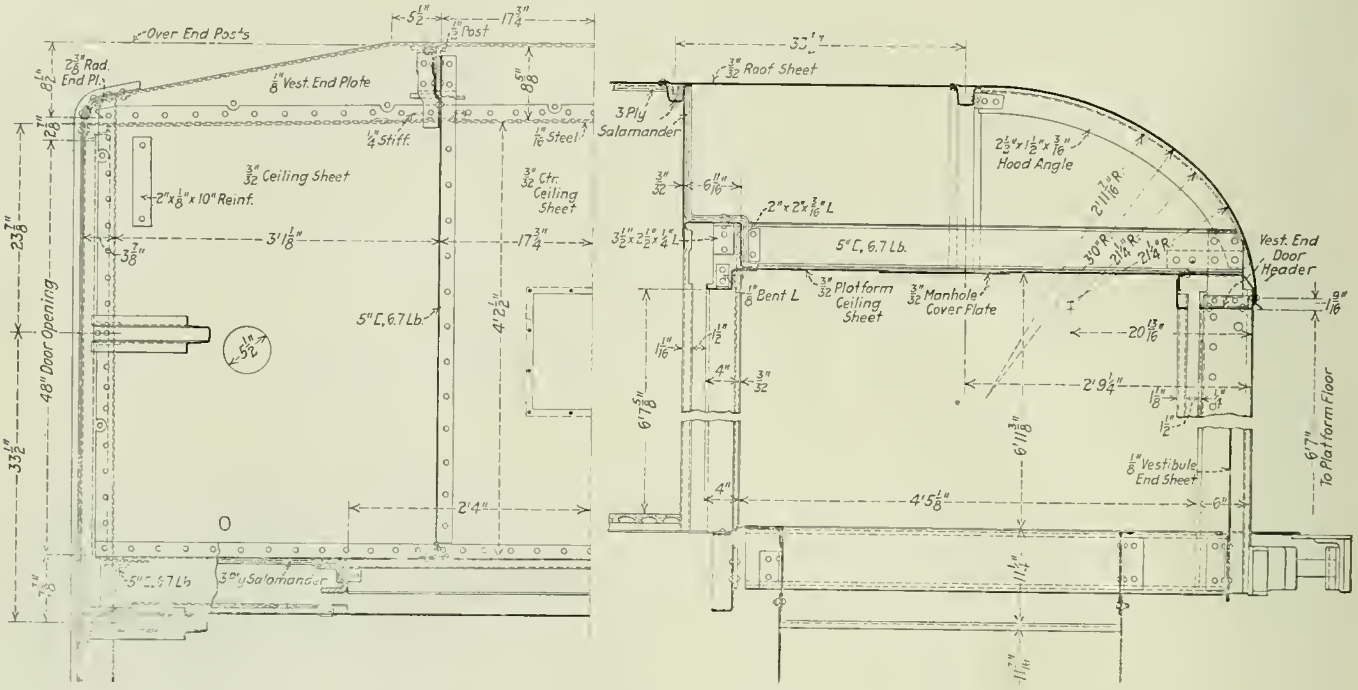
Air-Operated Sliding Doors Are a Feature of the Vestibule Design

The trucks are fitted with a device for adjusting the coupler height by raising the spring plank, shown in sections on the truck drawing. The device consists of a spring plank hanger pin or yoke provided with four bearing faces the radial heights of which are progressively increased. Progressive adjustments are made by turning these pins or yokes to bring the next higher space under the spring plank and substituting filler blocks with flanges of suitable depth

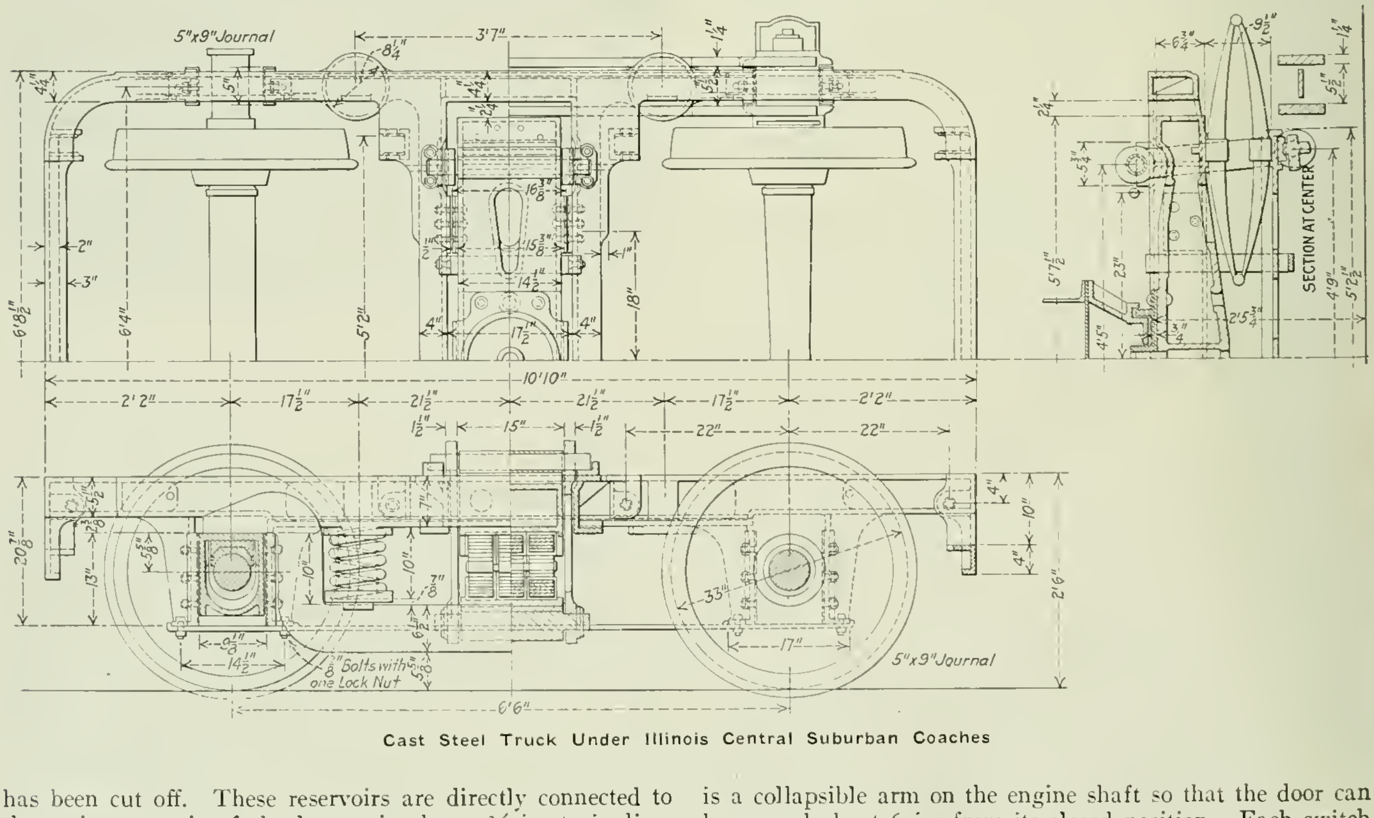
Door Operating Mechanism

All doors on these cars are of steel construction. The double doors at the ends of the car body are geared so that they operate together. They are arranged to lock both in the open and closed position.

The vestibule side doors are operated by air engines, one for each door, taking air from a reservoir under the car maintained at main reservoir pressure by direct connection with the locomotive. Each end of the car is fitted with one of these reservoirs which has sufficient storage capacity to permit the operation of the doors 10 or 12 times after the locomotive has been cut off. These reservoirs are directly connected to the main reservoir of the locomotive by a ¾-in. train line. No signal air line is provided as automatic electric signals are used in suburban service.



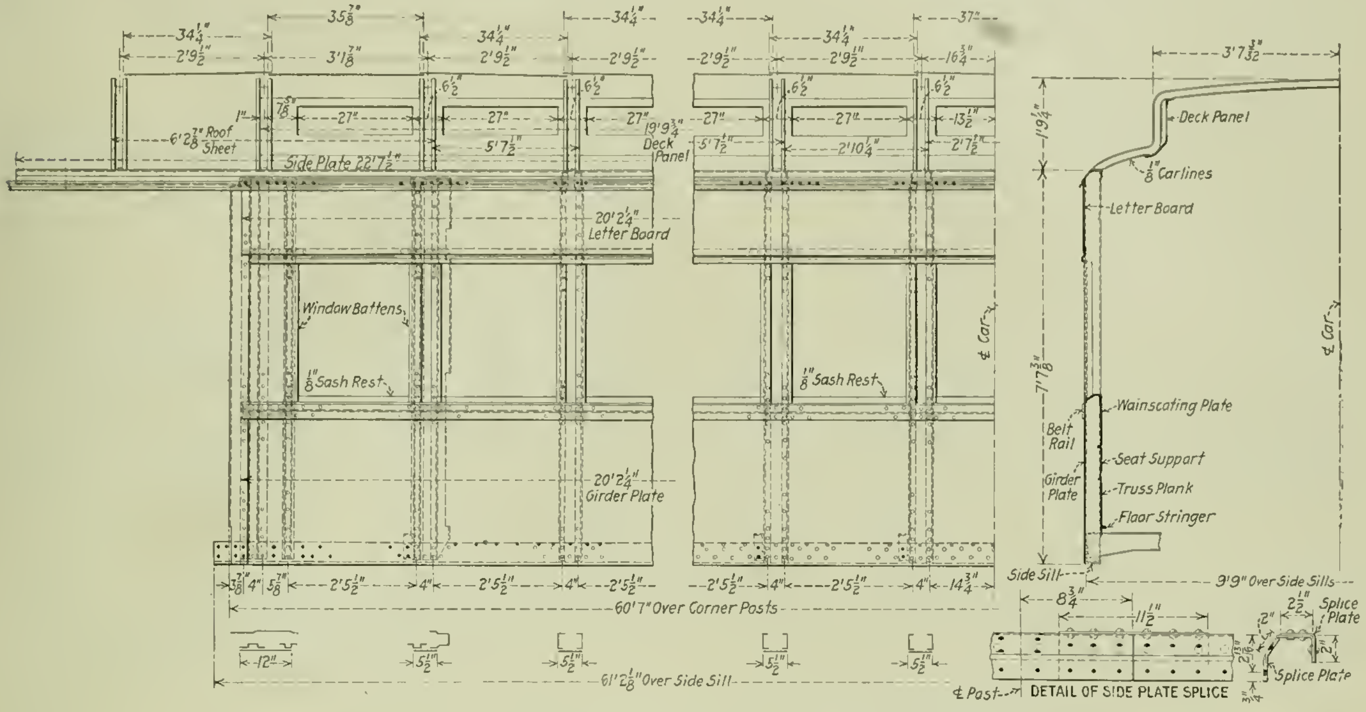
Sections Through Vestibule



Cast Steel Truck Under Illinois Central Suburban Coaches

The door operating engines are located under the longitudinal seats at the ends of the car. The operation of the air valves of this mechanism is electrically controlled by double lever switches which are mounted in cast iron boxes; secured to the outer faces of the vestibule door posts at both ends of the car. There are two levers, both arranged to lock in the neutral position, one for opening and closing the door and one neutral. As a further safety feature there is a collapsible arm on the engine shaft so that the door can be opened about 6 in. from its closed position. Each switch box controls both of the doors on one side of the coach, an arrangement which permits one guard to operate all of the doors on two cars. In event of an electrical failure the air valve may be operated by hand. In case a door is closed on an obstruction which prevents further movement it automatically opens about 36 in., then reverses and moves towards the closed position again. This movement is kept up automatically until the obstruction is removed. An electric contact mounted on the edge of the door and protected by a flexible rubber casing, causes this action.

A feature of considerable interest in connection with steam operation is an electric starting signal operated automatically by the closing of the doors. A green light mounted in the cab of the locomotive is connected to a series circuit carried back through the train by electrical connectors between the cars. This circuit is broken by the opening of any vestibule side door in the train and is closed only when all of the doors are closed. Closing the doors thus causes the lighting of the green lamp in the locomotive cab, which serves as a starting signal following station stops. The circuit for the automatic starting signal receives its energy from the headlight generator of the locomotive.



Side Frame Construction of Illinois Central Suburban Coaches

The Requirements for a Modern Car Repair Shop

Type of Building, Character of Tools and General Plan for Both Steel and Wood Equipment

BY H. H. DICKINSON AND PAUL SCHIOLER
The Arnold Company, Chicago

The inadequacy of facilities for the repair and maintenance of cars creates one of the most important problems which now confronts the executives of American railways. The enormous amount of capital tied up unprofitably in bad order cars is already a serious matter in railway economics and is growing worse through the increased unit costs of rolling stock. Furthermore, during repeated periods in more recent years, every railroad has been seriously hampered in its operations because the facilities for car repairs have not kept pace with the increase in the amount of equipment.

In planning a modern car repair shop the main points of consideration are the location, the site, the type, size and number of buildings, and the equipment, i. e., cranes, machinery, power, etc. Location and site are matters of local determination but in the selection and grouping of buildings and their equipment with apparatus, labor saving devices and machinery, certain specific recommendations and suggestions may be made.

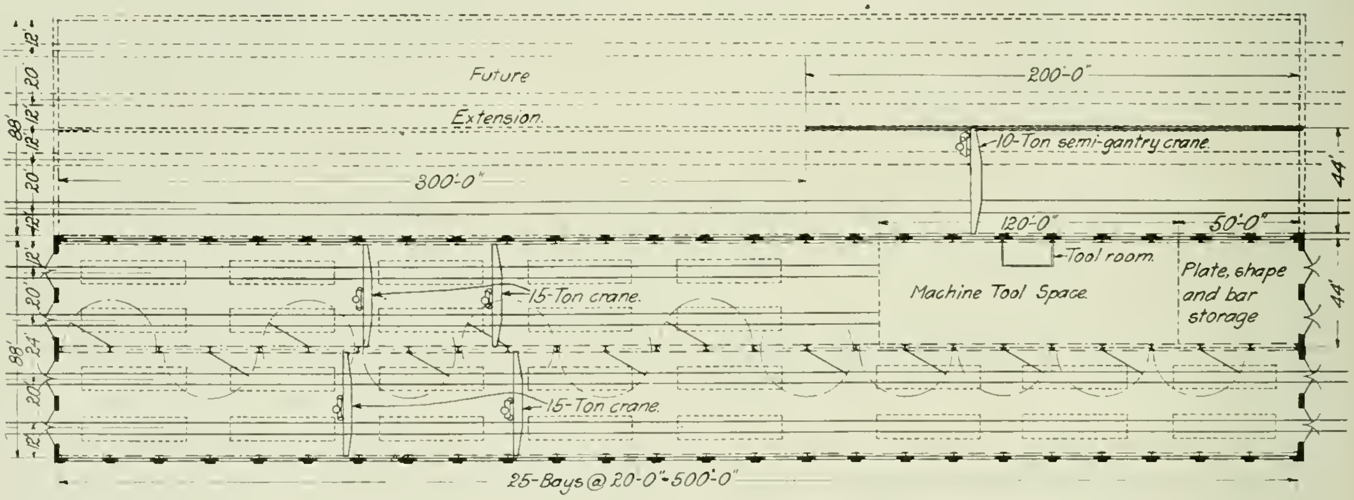
The work of repairing railway cars falls naturally in two main divisions; wooden cars and steel cars, with the intermediate one of cars with steel underframes and wooden tops. For wood car repairs frame buildings will usually answer the purpose in a satisfactory manner. It is true that they are not fireproof, but this does not add to the fire hazard from within, as the contents of such a shop are inflammable anyway, and the custom of supporting the roof in mill buildings on intermediate columns will, in fact, make them more desirable in this respect than steel truss buildings, as steel trusses collapse promptly under an inside fire. If it is desired to protect against fire danger from adjacent lumber yards, storehouses, etc., a fireproof roof covering may readily be provided.

The saw and planing mill operations involved in the preparation of material for wood car repairs are in reality a separate industry from car repairing. The following list of machinery is recommended for the average requirements:

1—four-cylinder sill and timber dresser, motor driven.
1—double-cylinder surfacer, motor driven.
1—planer and matcher, motor driven.
1—24-in. rip saw table, motor driven.
1—16-in. rip saw table, motor driven.
1—36-in. swing cut-off saw, motor driven.
1—24-in. cut-off saw table, motor driven.
1—vertical boring and mortising machine, motor driven.
1—car gainer, motor driven.
1—12-in. mitre saw table, motor driven.
1—24-in. jointer, motor driven.
1—48-in. band saw table, motor driven.
1—saw gumming machine, belt driven.
1—vertical car tenoner, motor driven.
1—wood lathe, belt or motor.
1—three-spindle vertical and radial car borer, motor driven.
1—flexible single spindle post borer, belt driven.

It is recommended that this machinery be housed in a separate building, or at least segregated in a room at one end of the car repair shop. The necessary system of shafting and pulleys, individual motor installations, ducts for the removal of sawdust and chips, and the whole organization of the millwork, are best handled in this manner. The efficient transportation and handling of material from car to pile and through the mill, and thence to the cars undergoing repair, is quite as important as is material handling in any industry, and it is best accomplished by properly arranged industrial tracks and yard cranes. Overhead crane service cannot be very well arranged in a mill constructed building, but for wood work only it may be dispensed with in most cases.

Work on steel cars and on cars with steel underframes as a rule compels the selection of steel frame structures, for the double reason that these are easily made fireproof throughout and they allow the proper installation of overhead crane service as well as the attachment of jib cranes in the most efficient manner. Moreover, steel trusses and steel sash, being of smaller dimensions than wood, allow a better diffusion of exterior light. Wherever climatic conditions permit, the sawtooth form of roof should be carefully considered, as it gives excellent light between cars standing on repair tracks. At any rate, the monitor sash or roof lighting should be placed crosswise over the tracks. Monitor sash should be arranged for ventilation and the side wall sash should also be provided with ventilated sections. Factrolite glass is recommended because of its superior diffusion of light and the elimination of shadows. Artificial lighting is best obtained by using tungsten lamps with enameled steel reflectors; the distribution of lamps must provide for full illumination of the spaces between cars on tracks.



A Steel Car Repair Shop with a Longitudinal Arrangement in Two 44-ft. Aisles

The best artificial heating system is a combination of direct radiation and indirect or fan blast heating, the direct radiation to be distributed along the building walls in proper quantity to compensate for the glass area exposure, and the fan blast outlets to provide heat for the center area of the shop and to take care of the requisite air circulation. If because of the character of the ground or for other reasons, underground ducts are undesirable, individual motor-driven fan heating units may be used to advantage.

Either Longitudinal or Transverse

No universal choice can be made between the longitudinal and the transverse type of shop. If the former is decided upon, a unit span of about 84 ft. between crane rails permits of a good crane arrangement and allows for four through tracks, 20 ft. center to center, and a 12-ft. space between each outside track and the wall. From 60 to 65 ft. of track should be allotted to each car spot and the length and number of building units determined accordingly. Machine tools should be installed on one side of the shop, leaving out a portion of the through track at this point. In a transverse type of shop the cranes will have a span of about 65 ft. and the machine tools will be placed at one end of a shop unit. The height of the crane runways should be 25 ft. and the clear height under trusses 32 or 33 ft. The building should be piped for air and acetylene, a double air outlet to be provided for every car spot and an acetylene outlet for every two car spots. The building should also be wired and have a contact at each car spot for the attachment of modern electrical tools.

The best flooring for car repair shops is creosoted wooden blocks on a concrete base. This is usually preferred by mechanics where nothing in the industry militates against its adoption, and in work of this nature there are no objections to this floor. It is durable, sanitary, non-conducting as to heat and cold and affords a satisfactory foothold.

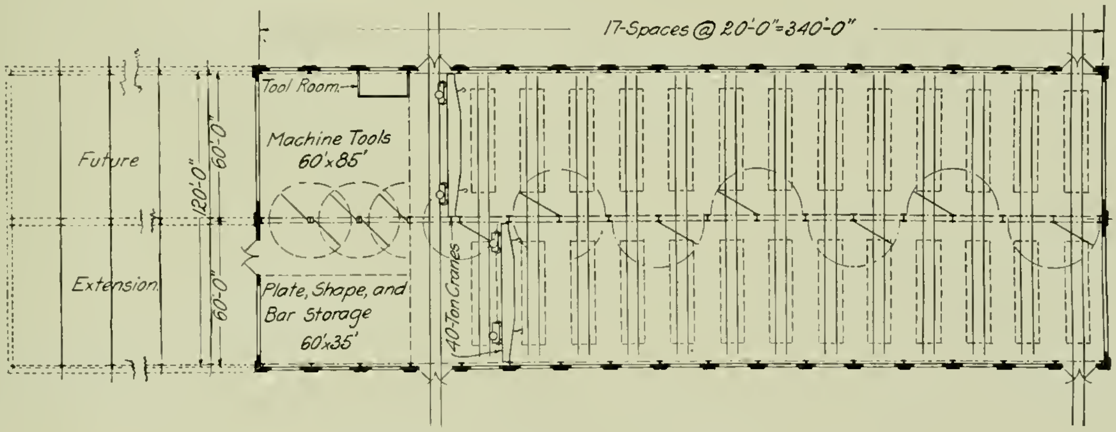
Adjoining the machine tool area racks for the storage of a reasonable quantity of large sheets and plates should be provided as well as storage facilities for bars and shapes. Storing this material inside the building not only permits unloading and storage by crane and provides crane conveyance to machines without extra handling, but it also eliminates deterioration from rust and other defects occasioned by continued exposure. An important factor in the efficiency of the shop is the relative adequacy of the general stores, and it will be well to make ample provision for all materials and supplies required in overhauling all the types of cars for which the shop is intended.

To permit full use of tracks for the spotting of cars under repairs and to have the receiving and unloading of material interfere as little as possible with the car repair work in the shop proper, it is recommended that, where possible, material be received on a track outside of the walls. In such a layout a six or eight-ton crane, supported partly by yard columns and partly by the building columns and spanning the material track, is a profitable investment and should be installed.

Repairs and overhauling of cars result in the accumulation of a large amount of sheets, plates, bars, rods, etc., all partly damaged but having considerable reclamation value. It is good economy to provide, in the machinery equipment, suitable tools, such as straighteners (plate and bar), furnaces, bulldozers, bolt threading machines and nut tapping machines, in order that salvaged material may be reclaimed on the spot and either used immediately in the shop or turned over to the stores department.

The widest possible application of crane service is advocated as the most fruitful way of securing an intensive utilization of the plant as a whole. The maximum load to be handled by cranes is usually between 25 and 35 tons, but the average load is much lighter. Two cranes of 15-ton capacity each may readily be operated together to handle a maximum load when occasion demands, and for general purposes they serve the shop better than it is possible to do when the crane capacity is concentrated in one machine of, say, 30 tons size.

It has already been stated that truss spans giving approximately 84 ft. between crane rails are desirable in longitudinal shops. For flexibility of crane service it is best to substitute for this two bays of 44 ft. each. The use of center columns should enable the designer to lighten the steel work in the roof trusses and provide good support for jib cranes. It will be less expensive to install two 42-ft. cranes and equip each one with a 15-ton hoist and an auxiliary rapid hoist of smaller capacity, than it would be to put in one crane of 84 ft. span, and they will serve the shop more efficiently. It is recommended that the lengthwise travel of cranes be limited to 300 ft., preferably about 250 ft., so that a shop unit from 500 to 600 ft. long should have at least two cranes, or sets of cranes. Jib cranes of the portable type, or attached to steel columns are an excellent means of handling work at car spots and at certain of the machine tools. They release the overhead cranes for general transportation and material handling through the whole shop. The jibs should have about a 20-ft. swinging arm and should be of at least one ton capacity.



Plan for a Steel Freight Car Repair Shop with a Transverse Layout, Two 60-ft. Aisles

The painting in a modern car repair shop should be done by pneumatic sprays. This applies to wood and steel work alike. It may be desirable to have the plant equipped with a sand blast outfit, so that when steel cars or underframes require thorough cleaning the work may be disposed of in the most efficient manner. However, only a fraction of the cars passing through the plant will need this treatment, and unless the capacity of the plant calls for at least 20 cars per day, a sand blast equipment can hardly be installed advantageously.

The wheel and axle work must be handled by a wheel lathe, an axle lathe, a wheel press and a wheel boring machine, and if the shop is about 84 ft. by 600 ft., or its equivalent, these tools are best placed among the other machine tools and the work organized to co-ordinate with the other shop operations. If, however, the layout provides for two or more shop units, then the work on wheels and axles is best done in a separate department located adjacent to the shops and operated in conjunction with them, leaving the shops proper to handle repairs to car bodies and underframes exclusively. One wheel and axle department will, of course, serve a steel car and a wood car shop.

Tools for Steel Car Work

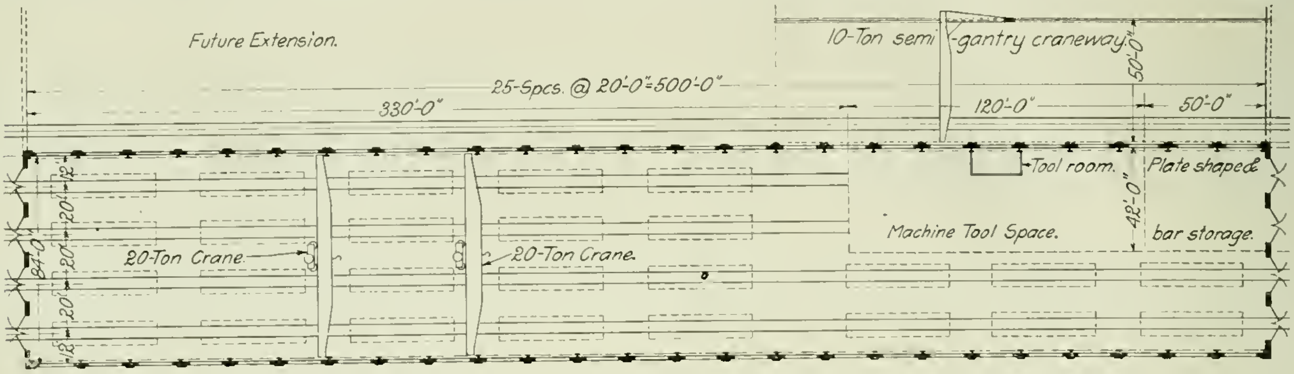
The following machine tool equipment is recommended for a car repair shop which is to handle the variety of types of steel cars used on the majority of railways:

One single end punch (24 in. throat), motor driven.
One double punch and shear (30 in. throat), motor driven.
One double horizontal punch and bending machine, motor driven.
One 8-ft. gate shear (cap. ¾ in. plate), motor driven.
One 6-in. by 6-in. by 1-in. angle shears, motor driven.
One alligator bar shear, motor driven.
One plate straightening press, pneumatic.
One 9-ft. by 14-ft. plate heating furnace, oil and gas burning.
One 12-ft. flanging clamp, pneumatic.
One 7-ft. by 10-ft. plate heating furnace, oil or gas.
One heavy duty bulldozer, motor driven.
One 5-ft. by 8-ft. furnace, oil or gas.
One 2-in. bolt heading, upsetting and forging machine, motor driven.
One forging furnace, oil or gas.
One 2½-in. double head bolt cutter, motor driven.
One 300-lb. power hammer, motor driven.
One 30-in. by 3-ft. furnace, oil or gas.
One 1,000-lb. steam hammer, steam.
One 3-ft. by 4½-ft. furnace, oil or gas.
One 6-ft. radial drill, motor driven.
One 4-spindle drill press, belt driven.
One 4-ft. drill press, belt driven.
One 26-in. drill press, belt driven.
Two heavy emery wheel stands, motor driven.

This list is in addition to any tools for reclaiming materials and does not contain the wheel and axle tools referred to in a preceding paragraph. The list is necessarily empirical and must be reviewed and compared with the individual requirements of any one shop under consideration. It is manifest that when, for instance, a shop is being laid out to handle principally the repairs of one type of steel cars, some of the tools mentioned may well be omitted and several others added; indeed these notes do not represent an attempt to design in detail any one particular car repair shop.

A number of railroads have experienced considerable annoyance and suffered a large aggregate loss as a result of too frequent loss of identity of freight cars undergoing repairs. A timely reform in the operation of car repair shops would be the adoption of uniform methods of checking the number on a car brought into the shops, preserving it upon the car while it is under repairs and checking it out again, but such a reform, to have the desired effect, would have to be universal in the shops of all railroads.

When a modern car repair plant is contemplated it is almost invariably the intention to provide steady employment for a number of workmen. Therefore it is advisable to provide a service building, located as conveniently as possible to the plant entrance. This building need not be elaborate, but it should contain a requisite number of steel lockers, lavatories and toilets and also some shower baths of approved sanitary design. There should also be a room where the men can eat their lunch during cold weather.



A Steel Freight Car Repair Shop with a Longitudinal Arrangement in an 84-ft. Aisle

These suggestions and recommendations, although specific and based on examination of actual conditions on the roads and in existing shops, will only be found of value when carefully considered with all the local conditions and circumstances bearing upon the individual project of any railroad.

Thus, the question of location and site, as regards labor conditions, topography of the prospective site, climatic conditions, fire protection facilities and proximity to railway terminals from which empty cars would be received must be gone into and decided upon in every instance, and the foregoing notes must be considered with the questions of the volume and class of work, frequency and season of maximum demand, average daily requirements and desirability of provisions for future extensions.

The three typical layouts shown embody some of the general desirable features mentioned. They are, of course, not intended to serve even as finished sketches of any one specific project, but they may form a basis for study and discussion and a nucleus around which layouts may be developed for particular conditions affecting car repair shops with the contiguous building for mill, wheel shop, store house and other accessory departments.

State laws already passed which deal with car repair shops and sheds give ample proof that the development of such buildings is anticipated by interests outside the railway executive offices. Such legislation is largely fostered by labor organizations and the efforts have been to provide the best working conditions and physical protection for the men employed. However, to obtain the best results the planning should be on a broader basis than this and the matter of proper protection for workmen should be viewed simultaneously with consideration of efficiency and economy in the operation of railroads.

In conclusion, attention is drawn to the fact that in comparison with the investment in modern power repair facilities the sums expended to date in car repair shops are but small—probably less than 20 per cent of the former—and yet the annual expenditures for maintenance of rolling stock usually greatly exceed the cost of maintaining locomotives. It has been demonstrated that it has not been possible to realize the ultimate efficiency of the modern locomotive equipped with superheater and mechanical stokers, because repair shops have not kept pace with improvements in the locomotives. It is logical to conclude that the enormous investment in cars may be made more profitable by providing the means for keeping them in shape. By planning car repair shops with some consideration for the observations made above, the results will certainly make for increased efficiency of the mechanics, whose work will, in fact, be changed from an open air occupation, with all the elements of uncertainty peculiar to such work, to modern shop employment of the highest and most satisfactory type. The roads will profit through better workmanship, less frequent delays; improved scheduling of car repairs and lower costs of maintenance.

The Pajaro Valley Consolidated Railroad Company, operating between Salinas and Spreckels, California, a distance of 41 miles, having been authorized by the state railroad commission, will discontinue certain trains and run automobile stages in place of them. The stage line will parallel the railway and will carry passengers, baggage and express at the same rates as are charged on the trains.

* * *

Copyright by Ewing Galloway, N. Y.

On the Bagdad Railway, Syria

Phantom Illustration of Glass Enameled Tank Car for Transporting Milk

Handling Milk in Specially Constructed Tank Cars

Large Glass Lined Steel Tanks Save Expense in Handling and Haulage—Refrigeration in Transit Eliminated

TANK cars have been used in the past for the bulk transportation of various kinds of liquids, but as far as known no one has attempted the experiment of employing tank cars for the rail transportation of milk previous to their recent adoption by the Baltimore & Ohio on one of its routes out of Pittsburgh.

Milk is one of the most important and one of the most extensively used food products, but it is unfortunately highly perishable and subject to contamination. It cannot be stored for future use but must be collected and transported to the consumer every day. Comparatively few persons fully realize the extreme care that must be taken in the production and handling of milk to insure its sanitation and freshness. It must be chilled promptly and maintained at a uniformly low temperature during transportation for a distance sometimes as much as 300 or 400 miles and all containers must be thoroughly sterilized each time before they are used.

The time honored container for transporting milk has been the 10-gal. can. These are received by the railroad from various milk stations and transported in special refrigerator cars to the distributors in the city who empty the cans and bottle the milk, the emptied cans being returned to the producer. The increasing cost of materials, icing, labor, losses, etc., has been a serious problem for the dairy distributor. There has been difficulty also in maintaining an even temperature by refrigeration on account of the changing atmospheric conditions and the extreme sensitiveness of the product. Any forward step that bids fair to improve the situation is therefore of interest to the railroads as well as to those engaged in the production and distribution of milk.

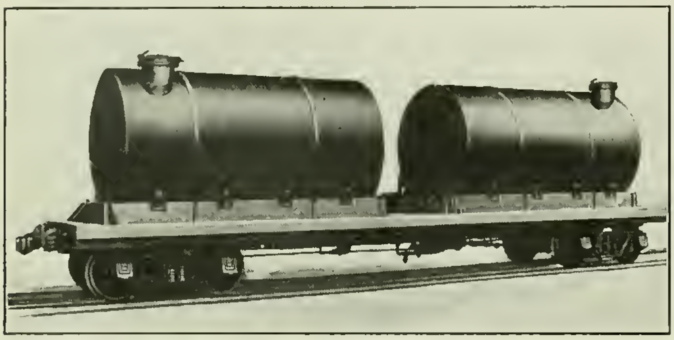
The Pfaudler Company of Rochester, N. Y., manufacturers of glass-enameled steel products, working in conjunction with the Baltimore & Ohio and the Harmony Creamery Company, has perfected a milk car with glass lined tanks. Three of these cars are now in regular service on the Baltimore & Ohio between West Farmington, Ohio, and Pittsburgh, Pa. These refrigerator cars, numbers 897, 898 and 899, are 39 ft. 9 in. long and 8 ft. 3 in. wide, inside measurements. They were originally equipped with brine and ice tanks for refrigerating purposes; these were removed and two steel glass-lined tanks, 11 ft. 2 in. long and 6 ft. 5 in. in diameter were installed. The tanks are made of open-hearth steel plate of a seamless welded construction, and have a capacity of 2,500 gal. each, a total of 5,000 gal. per car, or practically double the capacity of the same car when fitted for transporting milk in the ordinary 10-gal. cans. Each glass-lined tank is provided with sanitary outlets so located as to insure perfect drainage. They are also furnished with manholes at the top provided with quick closing swivel type doors which are air tight, thus increasing the protection of the milk and adding to the insulation efficiency.

The old refrigerator milk cars weighed 51,300 lb. light. Two hundred and fifty 10-gal. cans at 12½ lb. each weigh 3,125 lb. and hold about 21,000 lb. of milk. The actual weight of milk carried was thus only 28 per cent of the total weight of the loaded car, which was 75,425 lb.

The cars after being rebuilt weighed 71,600 lb. with tanks and equipment added. The 5,000 gal. of milk carried weighs about 42,000 lb. or 37 per cent of the total weight of the loaded car, which was 113,600 lb. The total weight to be hauled by the railroad when using tank cars, either loaded or empty, is thus 25 per cent less than by the ordinary method of handling milk in cans.

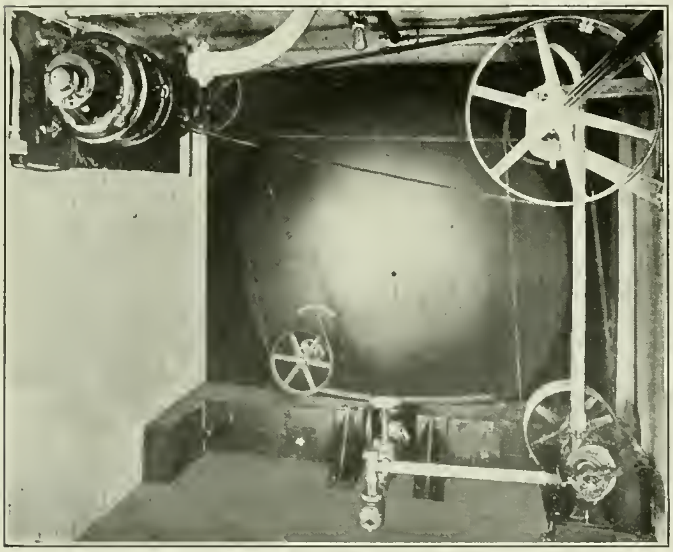
In practice the milk is brought in from surrounding farms, inspected and, if satisfactory, dumped into receiving tanks and then passed on to the cooler, where it is chilled to a temperature of 38 to 40 deg. From here it is pumped into the car tanks and transported to Pittsburgh.

The cars are equipped with an electric motor which receives current through a cable temporarily connected at the receiving point and is used to operate an agitator inside the tank and a pump for emptying the tanks. Before emptying a tank the agitator is operated for about five minutes to insure a thorough mixing of the milk and cream in the tank. The contents are then pumped out by a rotary pump which raises it to the top of the car where it flows by gravity into a tank on a motor truck which transports it to the dairy which is some distance from the railroad. In cases where the car can be switched to a siding at the receiving dairy, the milk would, of course, be pumped directly into tanks in the dairy.


Tanks on Car Without Body

The insulating efficiency of the tanks is shown by the fact that during a run of 107 miles from West Farmington to Pittsburgh, and an elapsed time of eight hours, there was a loss of less than two degrees, this result being obtained in August, when the outside temperature reached 88 deg.

There are a number of advantages in the use of these tank cars as compared with the ordinary method of handling milk in 10-gal. cans, among which the following may be mentioned: The carrying capacity of the car is doubled. The three tank cars have replaced seven old style refrigerator cars.


Interior View Showing Tank, Motor, Agitator and Rotary Pump

The expense of labor and material for icing and brine is eliminated as no refrigeration is required enroute. On the run referred to the charge for icing was seven cents per can.

The tank car method is more sanitary and the milk is kept at a more uniform temperature.

The labor in connection with the loading and unloading of the milk is greatly lessened. No cans have to be handled and shipped back to the owners. Since the adoption of the tank cars the Harmony Creamery Company has been able to dispense with the services of seven men and one three and a half ton truck formerly used to transport cans to and from the cars.

There is less loss of milk which adheres to the containers. The loss from this source is not over eight quarts per day for the two glass-lined car tanks, pumps and piping as compared with one-quarter pint per can or 63 quarts for 500 cans.

The expense of steam and washing compound for the daily cleansing of the car tanks is small in comparison with the expense in connection with the material and washing machinery required for the number of cans necessary for handling the same quantity of milk.

Claims for stolen milk, cream or cans is eliminated as the milk is safe in the large tanks.

It is estimated that the expenses of transportation in tank cars will be 75 per cent less than in cans, or in other words it is anticipated that under the conditions prevailing in Pittsburgh there will be an annual saving amounting to about $10,000 for each tank car used.

British Views on Fuel-Oil Installations*

The mechanical and economic questions involved in the use of fuel oil are receiving the same serious consideration in England as in the United States. During the recent British coal strike C. E. Stromeyer, chief engineer of the Manchester (England) Steam Users' Association, investigated a number of oil-burning installations and submitted his findings to the association in an eleven-page report. The following information abstracted from this report may be of interest.

The types of apparatus in use may be classified as: (a) The pressure-jet system, (b) the steam-jet system and (c) the air-jet system. In the pressure-jet system the oil is atomized by pumping it under pressure through specially formed burners from which it issues with a whirling motion at high velocity. The atomizing is generally better than in the steam or air-jet systems, and combustion may be almost perfect in this type, but the installation, involving a pumping set and special furnace fronts, etc., is considerably more costly.

The air-jet system is little used in power plants because the provision of a compressed-air supply is less convenient and generally more costly than steam, while the system is less efficient than the pressure-jet system.

The sudden cooling of boilers and brickwork should be avoided. Silica firebrick, in particular, is resistant to high temperatures, but is likely to crack if cooled suddenly. Hence, when shutting down a boiler having silica brickwork, it is necessary to keep the air-admission openings closed and allow the brickwork to cool gradually.

Regulation of boiler duty should be effected by adjusting the flow of oil and the air admission. For good results there should be a light-gray smoke at the chimney top. Absence of smoke usually means inefficiency through too much air, while dense black or yellow smoke means too little air or bad atomizing of the oil.

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*Reprinted from Power.

It is Interesting to note that in many of the larger countries abroad the heavy trunk-line electrification projects in the United States have been very carefully studied and are very frequently referred to by foreign consulting engineers in their reports, and that in several instances standard American plans have been adopted practically complete by engineers advising foreign governments on steam railway electrification. It is believed that the experience of American manufacturers in developing reliable heavy railroad equipment in this country will be of considerable help in negotiating a foreign contract.—*Commerce Reports.*

Two Boiler Shop Tools

BY E. A. MILLER

The gage, illustrated in Fig. 1, has proved a valuable tool for indicating the wear of arch tubes in locomotive boilers. Arch tubes often wear thin due to supporting the arch brick or the wearing action of rapidly moving gasses carrying solid particles which have an abrasive action. The arch tubes are three inches in outside diameter and it is evident, therefore, that a gage, constructed as shown in Fig. 1, when applied to a new tube will bear on the tube at three points.

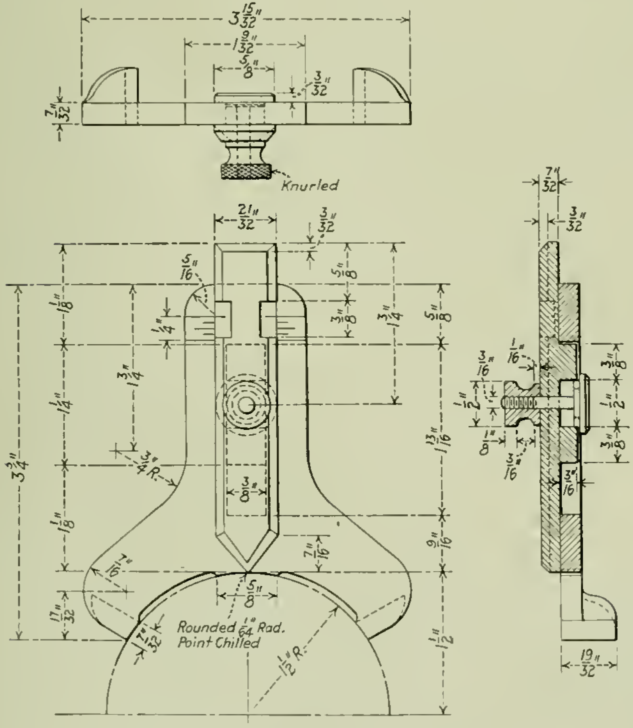

Fig. 1—Gage for Detecting Worn Arch Tubes

The gage is made to the dimensions shown, being provided with a movable pointed slider, graduated at the end to indicate relative positions.

Should an arch tube be worn the gage when applied will not bear on all three points and the point of the slider will extend beyond its normal position. Tightening the set screw will then hold the slider in place and the amount of arch tube wear will be indicated by the reading on the graduations on the upper portion of the gage. Both gage and slider are made of 7/32 in. stock, the slider being guided by a rectangular projection which sets in a corresponding slot in the gage. It is evident that if the arch tube is worn 1/16 in. at a certain point, application of the gage to this point will show a reading of 1/16 in. on the gage.

It is obvious that the gage would give a false impression if used at a bend in the tube where the section is not circular, but experience at the shop where this gage is used indicates that wear does not usually take place at the bends and the gage, therefore, gives accurate indications of defective arch tubes.

Facing Off Electric Welded Tube Ends

For facing off electric welding on the back tube sheets the tool, illustrated in Fig. 2, has proved useful. This cutter is intended for use on small tubes although the same principle could be applied to larger superheater flues. As shown in the illustration, the shank is tapered to suit the air motor spindle and a large cutting portion, 3 in. long by 3 in. in diameter, is provided with a pilot pin on one end and 16 cutting teeth. The cutting end is bored out 1½ in. in diameter by 1¼ in. deep, then being drilled and tapped for the insertion of the pilot pin.

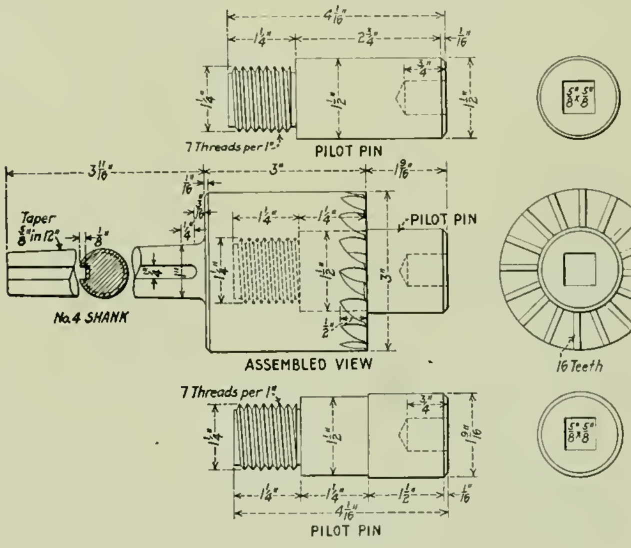

Fig. 2—Cutter for Facing Off Welded Tube Ends

The illustration shows two pilot pins, 1 9/16 in. and 1½ in. in diameter, one or the other of which will be found suitable for use in nearly all small tubes. The pilot pins are provided with a ⅝-in. square hole in the end as a means of inserting and removing them. The cutter is made of tool steel, hardened and tempered, and the pilot pins of axle steel. Should ordinary carbon steel cutters not be found to stand up under the somewhat severe duty of cutting electric welding, it may be necessary to provide high speed steel cutters either solid or with inserted teeth.

Planer Type Milling Machine Makes Record

Heavy Duty Miller Machines Ten Crossheads or Forty Driving Boxes in Eight Hours at Beech Grove Shops

BY JACOB MARTIN

General Foreman, Beech Grove Shops, Cleveland, Cincinnati, Chicago & St. Louis

THE Beech Grove shops of the Cleveland, Cincinnati, Chicago & St. Louis, under the direction of D. J. Mullen, superintendent of motive power, have been equipped with a 32-in. by 24-in. by 14-ft. Ingersoll milling machine of the four-head, planer type to cope with the demand for production. The results obtained constitute a record which will be of interest to railroad shop men.

This machine was purchased for milling driving boxes and crossheads and Figs. 1 and 2 show the machine set up for these operations. It is the practice of the Big Four to pour brass liners on the shoe and wedge and the hub faces of driving boxes, and it was formerly the practice to plane the shoe and wedge faces. Ten was the average number of driving boxes planed in eight hours at Beech Grove. Since machining driving boxes on the milling machine, we have obtained an average of 40 boxes per eight-hour day, the actual cutting time complete per box being five minutes; setting up time, seven minutes; making a total of 12 minutes from floor to floor for each box. The established feed is 40 ft. per min, for cutting speed, and 4.2 in. per min. for table feed. These speeds and feeds have proven desirable on this class of work as we machine from 80 to 90 boxes with one grinding of the cutters. It will be noted that the setting up time exceeds the cutting time, and the small amount gained by using a higher speed does not offset the loss in grinding or changing the cutters.

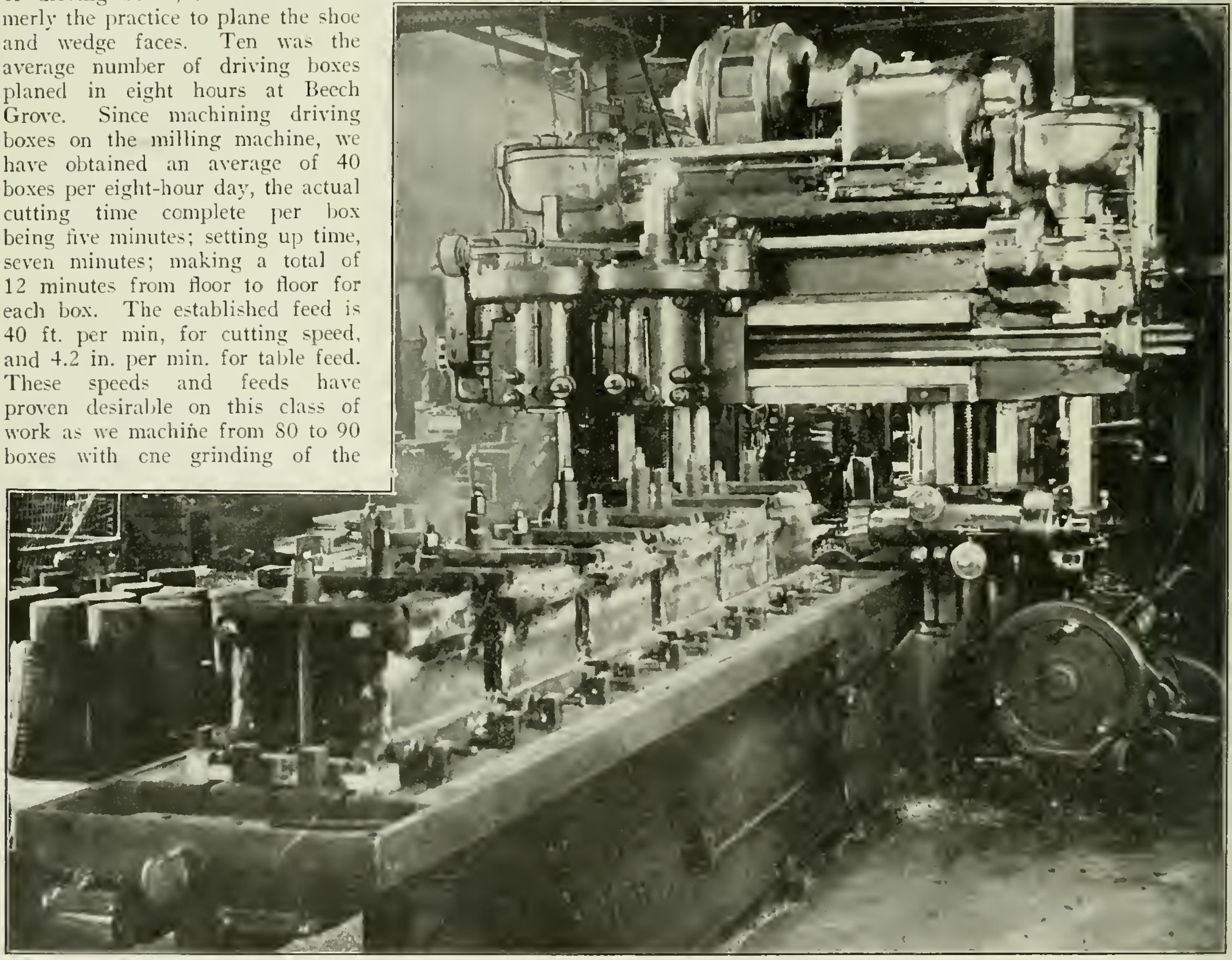

Fig. 1—Ingersoll 32-In. by 24-In. by 14-Ft. Milling Machine Equipped for the Rapid Machining of Driving Box Shoe and Wedge Ways

When old liners are tight on driving boxes and do not need renewing, but must be trued up on account of their worn condition or the shoe and wedge faces being out of parallel, it is not necessary to remove much material. In truing up old boxes we use a cutting speed of 60 ft. per min. with a table feed of 10.2 in. per min. This reduces the cutting time to two minutes per box and setting up time to seven minutes, making a total of nine minutes from floor to floor, for this class of work.

Machining Crosshead Shoes

It is also the general practice in railroad shops to plane crosshead shoes where soft metal is not used. The Big Four standard crosshead shoe is made of cast iron of the herringbone type, the cavities in the shoe being filled with soft metal. On account of the small projection at the top of each dovetailed groove, the metal is always more or less hard. The hardness of this metal makes unfavorable machining conditions, but gives good wearing service. The Big Four formerly planed these crossheads, approximately three being planed in eight hours. This job could not be crowded on a planer to any great extent on account of the tool breaking out portions of the cast iron at the top of the dovetail and forcing them into the soft metal. One familiar with the planing of a surface of this kind will appreciate the care that must be taken to get a true surface on account of the tool passing over a small portion of hard cast iron and then over a portion of soft metal. If great care is not taken the cast iron part will be high and the soft metal part will be low. The hardness of the cast iron still remains a factor in the milling of these shoes which is an explanation for the reduced table feed used by the Big Four. Ten is the average number of crossheads machined per eight hours. The table feed is 2 in. per min.; cutting speed for largest diameter cutter 40 ft. per min.; actual cutting time 28 min.; setting up time for first cut 12 min. and for second cut 8 min., making a total of 48 min. from floor to floor. With this machine we average 18 crossheads machined with one grinding of cutters.

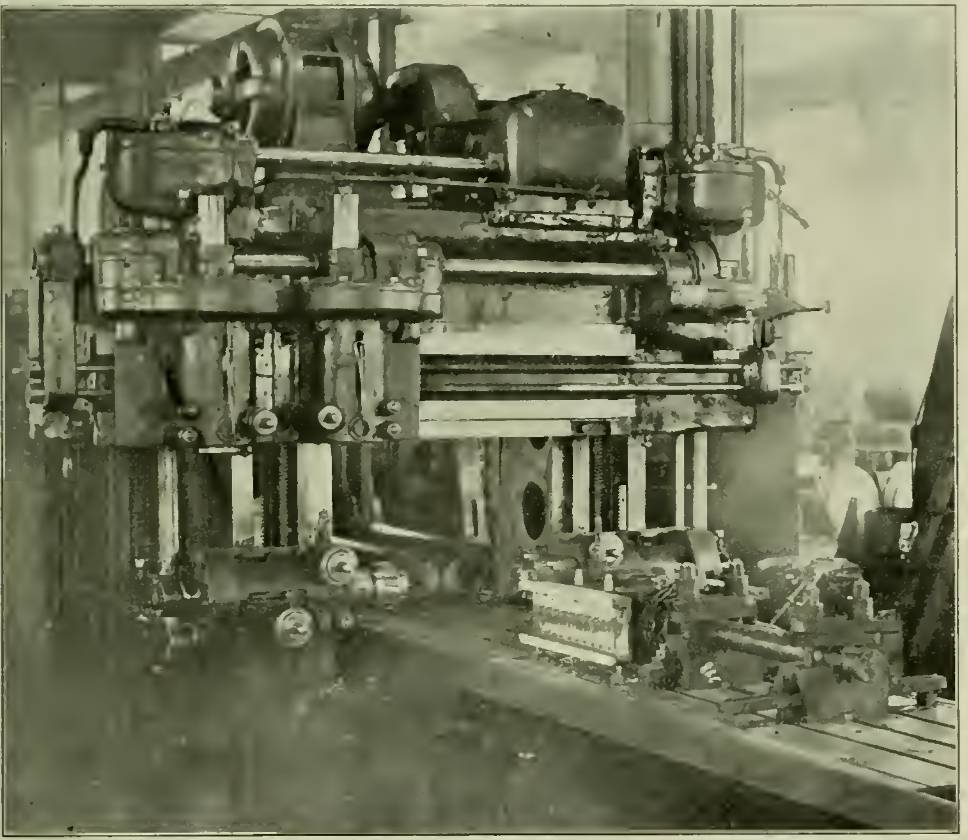

Fig. 2—View Showing Set Up for Machining Crosshead Shoes

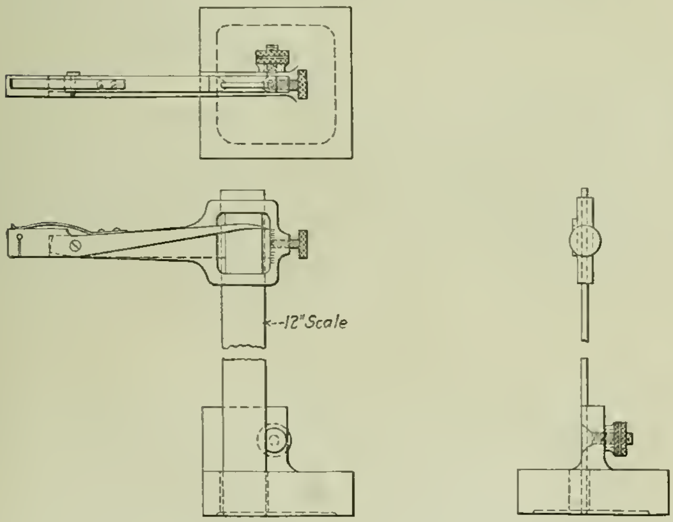

Fig. 3—Height Gage for Setting Milling Cutters

Advantage is taken of more favorable iron whenever possible to increase the table feed to 3 in. per min. and using 60 ft. per min. cutting speed for the largest diameter cutter. From the illustrations it will be noted that we use two cutters, in pairs, on the crossheads. The smaller diameter which works inside the crosshead shoe is removing the most metal; the outer cutter is only machining the outer surface to the proper height. Due to the small amount of metal being removed, this cutter stands up at a higher cutting speed.

The tools used in connection with this work are shown in the line drawings. Fig. 3 shows a height gage for setting cutters to the desired height. Fig. 4 shows a centering block and gage used for setting the part to be machined. Fig. 5 shows standard gages used in connection with the centering block for setting cutters to the desired width.

Advantages of Planer Type Milling Machines

The advantages of planer type milling machines using end and face cutters, over planers for production work cannot be denied. Some of the desirable features of the milling machine are :(a) The large percentage of total power consumed by actual cutting of the metal instead of moving the part machined and the machine table back and forth; (b) the continuous cut; (c) the reduction in time required for tool setting and grinding of tools. This adds to the efficiency of the operator and the quantity, quality and accuracy of the work is increased. The fact cannot be overlooked that on the planer there is only one tool cutting, while the milling machine will have from 12 to possibly 36 cutting points. The milling machine cutter, with the greater number of cutting blades, can be removed and replaced in practically

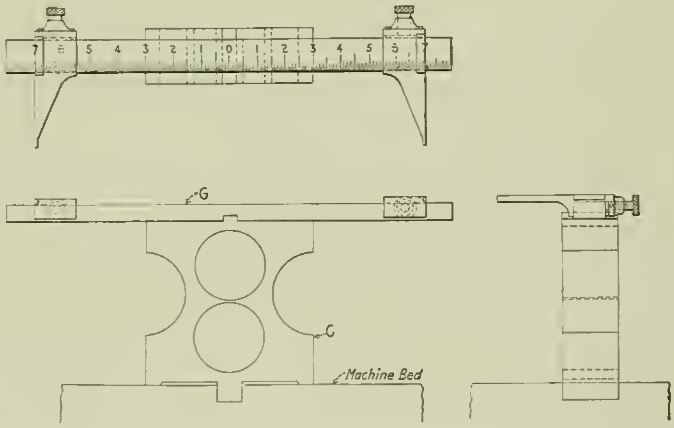

Fig. 4—Centering Block and Gage for Centering Work

the same time that it takes for the one tool on the planer. The grinding is also accomplished under favorable conditions on mechanical grinding machines so that machine will not be idle for tool changes or tool grinding more than a minimum length of time.

The mechanical departments of the railroads have as a rule been alert to the above facts but have been reluctant to install milling machines in place of planers due to the initial cost of purchase and installation and the fact that railroad repair work cannot always be handled on a production basis. The number of parts to be machined often does not warrant the investment in special cutters and is insufficient to justify a milling machine set-up. Another fact to be confronted is that castings received in railroad repair shops are not made for rapid machining, but to meet the requirements of the service, which as a rule results in more or less hard castings. Still another factor that probably has some bearing on the delayed adoption of planer type milling machines by railroads is the few machines of this type being used in railroad shops which would naturally cause some skepticism as to their value for this particular work.

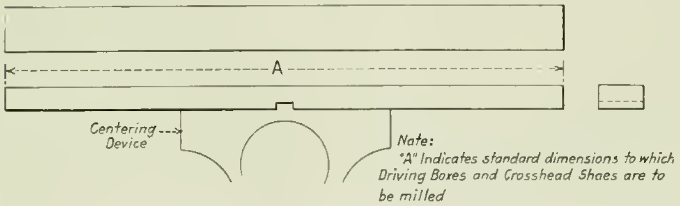

Fig. 5—Gage for Setting Work and Cutters

Large railroad shops are becoming more numerous and in analyzing shop conditions, it is common to find one or more machines confined to the manufacturing of a single part. This means that production methods and machinery should be installed and it was with this thought in mind that the Big Four developed the foregoing method of machining driving boxes and crossheads. The adoption of the milling machine enabled driving boxes to be machined four times as fast as formerly and crossheads a little over three times as fast.

Six-Roll Superheater Flue Expander*

There exists a difference of opinion among engineers as to the advantages and disadvantages of the six-roll flue expander as compared with the three-roll type for the superheater flue work. On small tube work, the three-roll expander is universally used, and when the superheater was fitted to British locomotives the expander for the large flues was designed on similar lines to the small tube expander. The roll box of the expander was made with an adjustable cap to enable the rolls to be adjusted to suit various tube sheet thicknesses. It is necessary that a flue should be expanded about 1/8 in. through the sheet, and the cap on the three-roll expander enables the operator to do this.

This cap is fixed, and therefore the length of roll is not controlled by the operator, an important point, since when new flues are inserted in a flue sheet they are first expanded, then beaded over and afterwards re-expanded. When this work is done by the six-roll expander the first expanding lays down only a portion of the flue, as the allowance for beading, 9/16 in. prevents the rolls from passing further into the flue. After the flue is beaded the re-expanding covers an additional portion of flue, which is not good in practice. This trouble does not exist when the three-roll expander is used, as the cap fits over the beading and rests against the flue sheet. The length of the flue expanded thus remains constant.

The three-roll expanders are fitted with a nut on the end of the mandrel, which is used for removing the expander after the flue has been sufficiently expanded. This nut is screwed against the box portion and the mandrel is thereby forced out. The pressure necessary to make a good joint is obtained by driving the tapered mandrel in with a copper hammer and turning with a ratchet. In the six-roll expanders the rolls are inclined, so that they will tighten up during the action of expanding. The flues are expanded by turning the mandrel to the right, and the expanders are released by turning the mandrel to the left. This is an advantage, as hammering the mandrel drives the rollers on to the flue at points of contact, and tends to make grooves in the tube surface. It is necessary that the inclination on the rolls be made so that they will not tighten the expander too suddenly, and at the same time be sufficient to release the expander without the operator having to resort to the use of a hammer.

An advantage which the six-roll expander has over the three-roll expander is that, having several points of contact, the tendency to straighten out the flue between the rolls is negligible. Consider a three-roll tube expander inserted in a tube 4 15/16 in. in diam. which is in position in a flue hole 5 in. in diam. The spindle, on being driven in, lays the flue down in three places, the metal of the flue between these points, about 5¼ in. apart, being lifted further through the flue sheet and somewhat straightened. A similar flue expanded with the six-roll expander would be opened evenly and gradually, as no driving of the mandrel is required with this expander.

After a boiler has been working for a time the flue sheet holes become misshapen, due to upward expansion of the firebox, downward thrust of the steam pressure on the firebox crown, and stress put into the flue sheet by expanding the flues. The flues in the misshapen holes give considerable trouble from leaking, and have to be re-expanded from time to time in the locomotive terminals. It is not economical to remove these flues and round up the holes by means of rose-bitting, as frequently the flues are of good thickness. It is possible to make such flues steam tight with a three-roll expander, but this cannot be done with the six-roll expander. When operating in an oval-shaped hole the mandrel of the three-roll expander takes an eccentric path, which allows it to press on the rolls as they pass over the portion of flue which is out of shape, thus allowing the flue to be made tight.

The six-roll expander will not do this, as having more points of contact the rolls are permitted to ride loosely over the misshapen portions of the flue. An experiment was made in this direction on a leaking flue, which was 1/8 in. out of round. The flue was covered with chalk internally and well expanded with the six-roll expanders. This failed to stop the leakage, and on removing the expander it was found that the chalk was cleaned from the sides of the flue, but remained on the top and bottom. On expanding the same flue with a three-roll expander the leakage was stopped and it was found that the chalk was well cleaned off all round the flue.

If expanding could be continued with the six-roll expander the flue hole would be rolled round, but this is not to be desired, as adjacent flues would be affected. Also the inclination on the rolls would prevent this being done, as the expanders would get so tight as to become immovable before the shape of the hole had been appreciably altered.

To sum up, the six-roll expander in its present form requires modifying and fitting with an adjustable cap which would make it most suitable for new work and for expanding flues in sheets which have had their flue holes rosebitted round. The three-roll tube expander is most suitable however for the tube repairs which have to be made in locomotive terminals.

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*From the November, 1921, Railway Engineer.

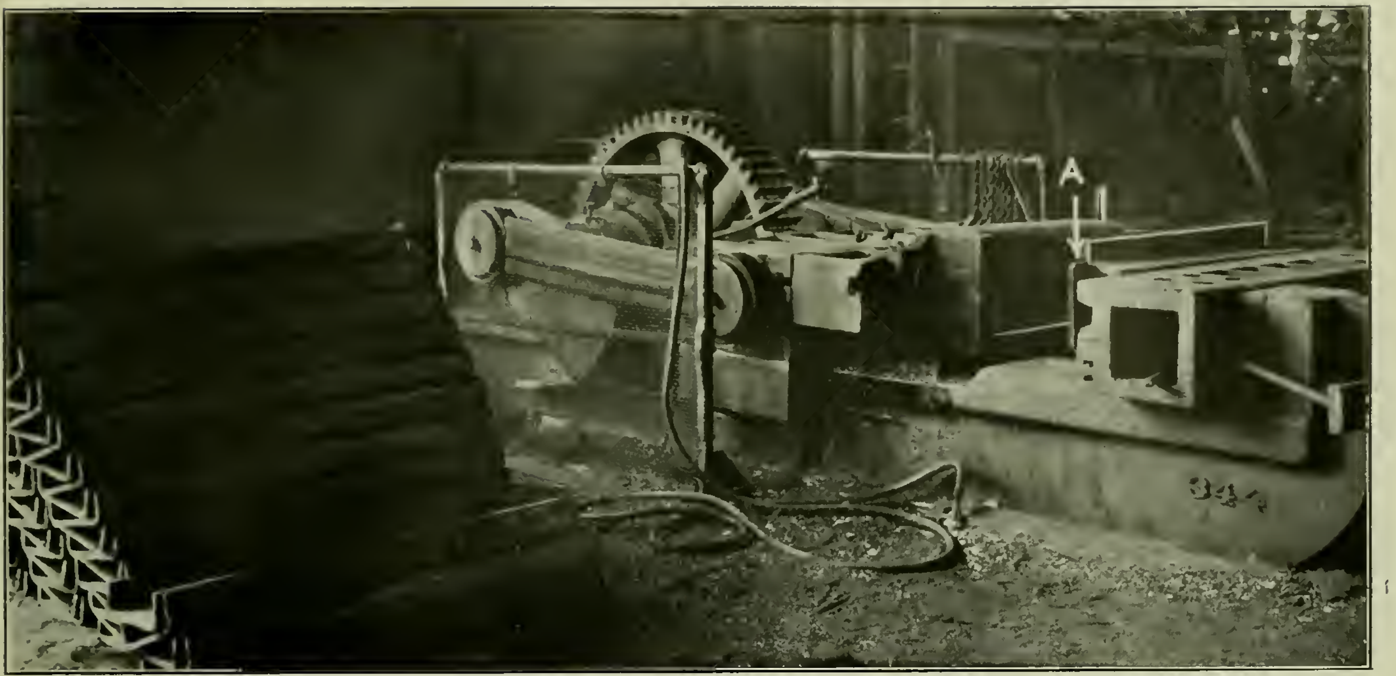

Fig. 1—Bulldozer, Fitted Up to Form Draft Sill Reinforcement Channels at One Stroke

Machine Forging Work at Elizabethport

Many Locomotive and Car Parts Are Made at a Minimum Cost by Use of Production Forging Machines

IT is generally admitted that the rapid increase of autogenous cutting and welding in railroad shops has made heavy inroads into the work formerly done by blacksmiths. In spite of this fact, however, 110 men, or approximately the normal pre-war force, are employed in the blacksmith department of the Jersey Central shops at Elizabethport, N. J., and the visitor at that shop can hardly fail to be impressed with the businesslike, production methods used in securing output. Probably this impression is largely due to the great amount and variety of machine forging work, varying from the manufacture of bolts to all kinds of forged shapes used at different points on the system. Credit for the development of this work and the design of the forging dies is due to G. W. Kelley, blacksmith foreman at Elizabethport and formerly president of the International Railroad Master Blacksmiths' Association.

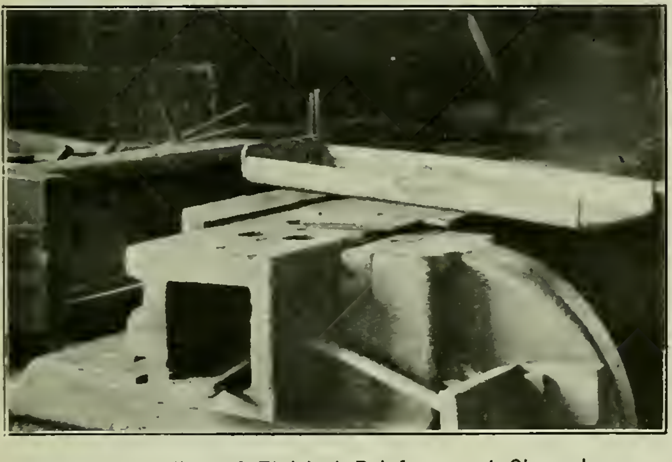

Fig. 2—View of Finished Reinforcement Channel

Four forging machines are used at the shop, including a No. 3 Ajax bulldozer, No. 5 Universal Ajax forging machine, 1½-in. Acme forging machine and 1¼-in. National hammer bolt machine. A wide range of work is performed on these machines and the four typical examples described below are given because of their general interest.

Draft Sill Reinforcement Channels

Channels, used to reinforce draft sills, are made at one stroke of the bulldozer illustrated in Fig. 1. These channels are made of ½-in. steel plate with 3-in. by 4-in. rectangles cut out at two corners, one being shown at *A*, Fig. 1. The plates before banding are 50 in. long by 17 in. wide and are drilled with three holes so that after heating they can be accurately located by pins on the solid former. (Plate shown in position before bending in Fig. 1.) One stroke of the movable die bends both sides and one end, leaving the chan-

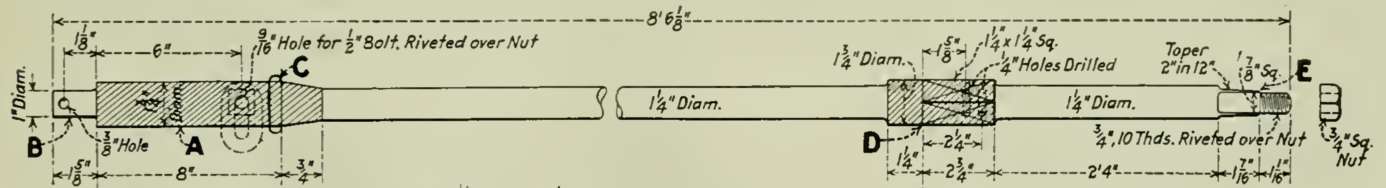

Fig. 3—Details of Brake Shaft Made of a Single Piece of 1¼ in. Round Stock Without Weld

nel in the form shown in Fig. 2, the channel then being 46 in. long by 11 in. wide, with two sides 3 in. high and one end 4 in. high. Three men are required for the manufacture of these channels which are made at the rate of 10 to 12 per hr.

Double Upsetting a Brake Shaft

Owing to the I. C. C. requirements that brake shafts for freight cars be made without weld, it is necessary to upset each brake shaft at two points a considerable distance apart. Fig. 4 shows a number of completed brake shafts fo 80,000-lb. capacity coal cars. Details of this type of brake shaft are shown in Fig. 3, from which it is evident that the shaft is made of 1¼ in. round stock upset at two points a distance of 5 ft. 7¼ in. apart. It is plain that if these two operations are to be performed on a forging machine some method must be devised to extend the dies for one operation allowing the rod to pass over the top of the machine. A set of shafts with one end formed are shown in the insert in the lower left corner of Fig. 4. The completed shafts are shown full length in Fig. 4, being upset and formed at points *B* and *C*. The preliminary operations are performed on the forging machine illustrated in Figs. 5 and 6. Referring to Fig. 3, the first operation is to upset the right-hand end of section *A* to 1¾ in. and 1⅞ in. in diameter. The second operation is to pinch section *B* to 1 in. round as shown. Section *A* is too long to be upset at one blow and the third operation therefore consists of upsetting the left-hand end of section A to 1¾ in. in diameter. The entire section *A* therefore is upset to 1¾ in. diameter, but with a slight taper, and the same blow which performs the final upsetting, pushes off the excess stock in the form of collar *C*, leaving section *A* 1¾ in. in diameter at one end by about 1⅞ in. diameter at the other end. This taper is removed by the hammer swager *A* (Fig. 6), operated under the vertical press which forms a part of the forging machine.

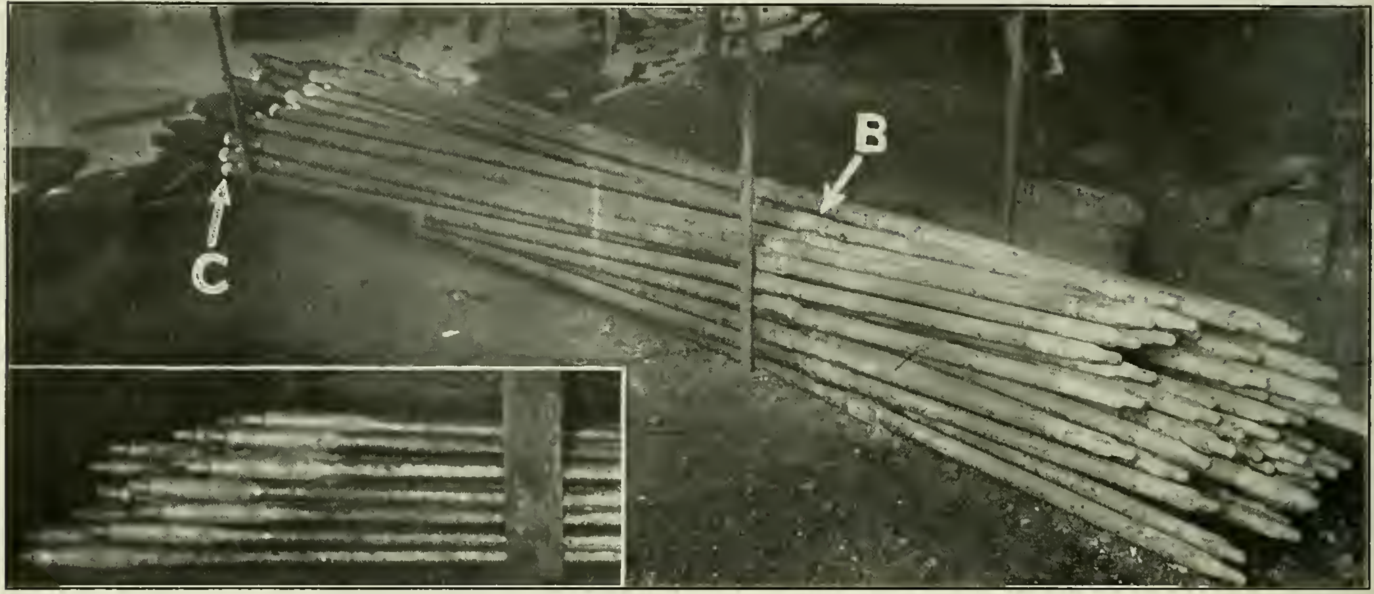

Fig. 4—Finished Brake Shafts Upset at Two Points, 5 Ft. 7¼ In. Apart

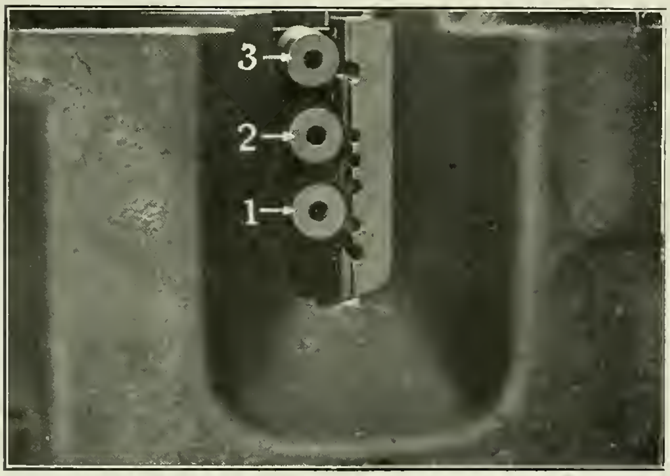

Fig. 5—Universal Forging Machine Equipped to Form Brake Shaft Ends

Referring again to Fig. 3 the second forging operation on the brake shaft is to upset section *D* 1¾ in. in diameter by 3¼ in. long using extension dies, half of which are shown in Fig. 7. These dies are secured in the forging machine in such a way that the upper part extends above the machine, allowing brake shaft end *A* to extend over the top of the machine so that a second upsetting operation can be performed at *D*. In Fig. 7 *A* is the moving die and *B* the fixed die. *A* and *B* are held in alignment by two pins and sep-

Fig. 6—View Showing Vertical Press and Hammer Swager

arated after each stroke by the two springs shown between them.

In operation the brake shaft is heated at the correct location and a similar pair of dies come against dies *A* and *B*, gripping the stock firmly. Die *A* then, in conjunction with its mating half, moves up to die *B*, compressing the heated portion of the brake shaft into cylindrical cavity *C*. It will be noted that one portion of brake shaft section *D*, 2¼ in. long, is square, the operation of squaring being performed on the vertical press equipped with a suitable hammer swager.

Fig. 7—Extension Dies for Forming Second Upsetting Operation on Brake Shafts

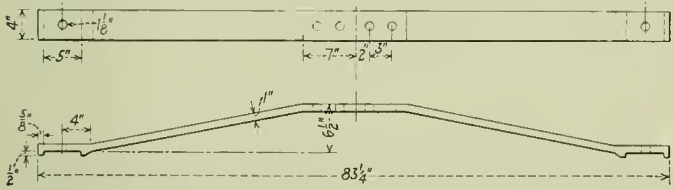

Fig. 8—Details of Tender Truck Cross-Tie

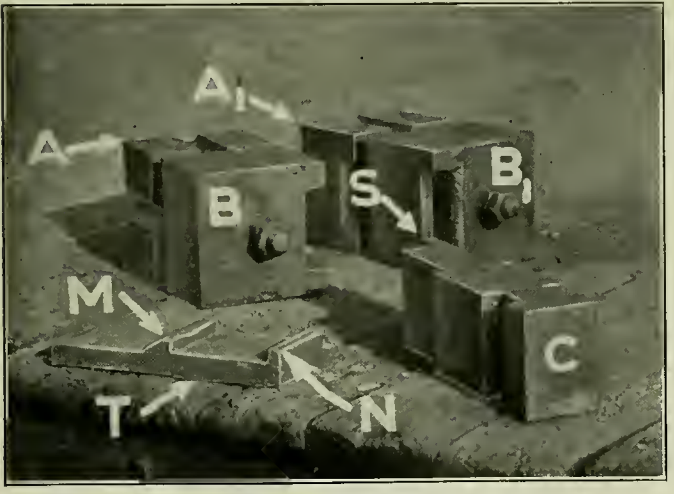

Fig. 9—Dies for Forming Cross-Tie Ends

The brake shaft end *E* (Fig. 3) is made under a power hammer because this is a simple operation which would be costly if performed on a powerful, high-priced machine. Two men are required to handle material and operate the machine while making brake shafts and sections *A* and *D* can be formed at the rate of about 15 per hour, the time required for making section *D* being slightly less than that for section A.

Tender Truck Cross-Ties

The details of a cross-tie for tender trucks are shown in Fig. 8 and this cross-tie is made from a single straight piece of 1-in. by 4-in. stock with the ends formed as shown and of the proper length to make the cross-tie, illustrated in Fig. 8, when necessary bends have been made. The dies for forming the ends are shown in Fig. 9, a view of sample end T being given to show the toes *M* and *N* formed by the dies.

The dies are set up in the forging machine, die *A* being solid. In operation the heated stock is fed in the proper distance and dies A_1 B_1 move over to dies *A* *B*, gripping the stock. Dies *B* B_1 then advance on *A* A_1, forming toe *M* and being forced to move by the advance of die *C* on the ram of the forging machine. Die *C* forms toe *N* on the cross-tie shearing off any excess stock by means of projection *S* passing into the slot in B_1. These cross-tie ends are formed at one stroke of the machine at the rate of approximately 20 per hr. depending upon the facilities for heating.

Method of Making Boiler Crow Feet

The dies for rapidly making boiler crow feet, also a finished crow foot, are shown in Fig. 10. *A* and *B* are double dies which can be used to make two sizes by simply reversing them in the forging machine.

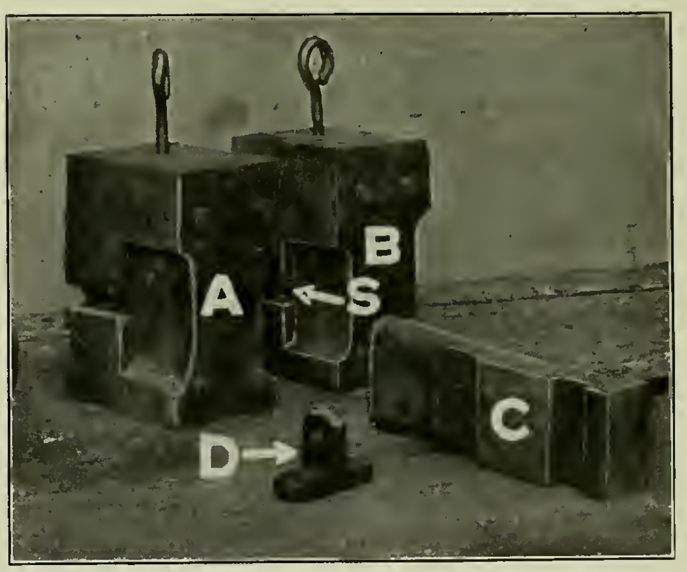

Fig. 10—Dies for Forming Boiler Crow Feet

In operation the 2¼-in. by 1-in. stock is heated and fed the proper distance into slot *S* between dies *A* and *B*. Die *B* moves against *A* gripping the stock and the advance of die *C* then compresses the excess material to form the crow foot, shown at *D*. Crow feet are cut off and shaped in one stroke of the machine at the rate of 25 or 30 an hour. The crow foot, illustrated, is 6 in. long by 4 in. high, being made of 2¼-in. by 1-in. stock.

Roch Lanctot, a prominent French-Canadian member of the Canadian Parliament, in a recent speech at St. Edouard de Napierville, Quebec, declared that the Government of Canada would be wise to rid itself as soon as possible of the publicly owned railways. "What is the use of adding to an investment that produces nothing but deficits?" asked Mr. Lanctot. "I would prefer to sell the whole thing to the Canadian Pacific for a dollar. The government is not capable of running railways on a business basis; there is too much temptation."

Standards of Railroad Shop Welding Practice

Workable General Rules Are Given; Also Typical Examples of Proved Boiler Welding Practice

BY G. M. CALMBACH
Welding Engineer

IN order that greater uniformity and better results may be obtained in preparing work and making welds, the following methods and practices have been selected after considerable study, experiments, and personal observation of the welding work in many shops throughout the country. They are considered the best and most practical methods in use today and are recommended as standard practices, to be followed as closely as local conditions will permit. Each foreman and welder who follows these instructions will find his work more reliable and satisfactory.

1.

In welding cast iron, brass, cast steel, and forgings, all such work should be fire-heated whenever possible to insure a better weld, as well as to save gasses. That is to say, all parts that take considerable time to heat with the torch sufficient to commence welding should be preheated so that when the welding flame is applied the part to be welded will respond almost immediately. As the oxy-acetylene torch cost per hour is extremely high it is easy to see that the heating of ordinary heavy parts with the oxy-acetylene flame is a very expensive operation and should be eliminated as much as practicable.

All foremen in charge of such work should use good judgment and take personal interest in this matter and see that the proper provisions are made and work carried out accordingly. The preheating of cast iron, brass and other heavy castings is not only necessary for the saving of gasses and time, but is also necessary in many cases to take proper care of expansion and contraction.

2.

In making a successful weld there are five very essential and important things to consider: namely, (1) Condition of surfaces; (2) bevel of sheets; (3) position of sheets; (4) provision for expansion and contraction, and (5) proper filler metal.

The importance of these points cannot be over-estimated and the failure to comply with the instructions covering any one of them will result in a questionable or bad weld. The success of a weld depends on the rigid observation of these items.

3.

When sheets and patches are to be applied extreme care should be taken that all defective parts are cut out and also that they are cut so there will be a good foundation for the weld.

4.

All sheets and patches should be cut out on a straight or uniform line, avoiding staybolts wherever possible so that staybolt threads may be cut in unwelded plate.

5.

Never cut out sheets or patches through the old weld where sheets have been welded previously. For side sheets or three-quarter door sheets, extend the new sheets at least one staybolt row higher; for crown sheet, one staybolt row lower; for patches, at least one row of staybolts larger; for flue sheet, extend weld to one row of staybolts lower.

6.

Do not cut out sheets or patches and bevel the sheets at the same time. If the sheets are to be beveled with the torch before chipping it can be done after the parts are cut out; this is necessary to insure a uniform line, as well as a more perfect fit of the new parts.

7.

Clean surfaces are absolutely necessary for making good welds. If scale, rust, or grease is permitted to remain on the surface to be welded a slag is formed that will make a streaked and seamy weld. All surfaces must be kept free from foreign substances; all welding surfaces must be kept clean and bright.

8.

Experience has proven that the most satisfactory angle of the beveled faces preparatory to making the weld is an angle of 45 deg. with the surface of the sheets. The total angle between bevel faces must be 90 deg. in all cases, even if one sheet has to be beveled more than the other. Improperly beveled sheets prevent the welding flame from properly penetrating the bottom of the weld and prevent the weld from uniformly uniting with the edge of the sheet.

9.

Where horizontal welds are to be made with the electric welder it has been found a very good policy to bevel the bottom edge to about a 60-deg. angle and the top edge to about 30 deg.

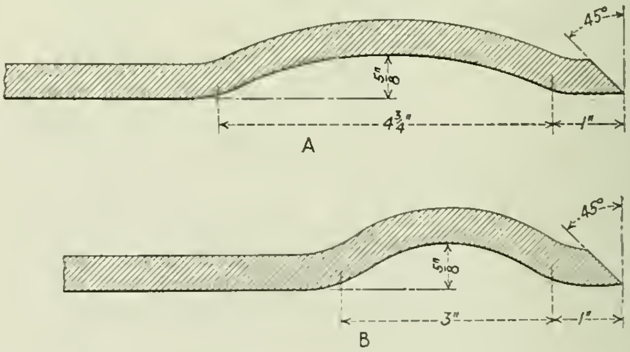

Fig. 1—Standard Corrugations for Boiler Sheets and Patches

10.

All sheets and patches are to be fitted carefully with an opening of ⅛ in., no more and no less, between bevel edges. Less than ⅛ in. opening between the sheets will not permit the welding flame to penetrate the weld properly and a greater opening requires too much filler metal to be used, not only increasing the cost of the weld, but making it impossible to keep the surface of the weld opposite the torch smooth. This rough surface permits lamination and seams on the water side of the sheet, weakening the weld and permitting early corrosion of the metal which tends to part the sheets.

11.

All other precautions may be carefully made and yet a faulty weld will be made if due care is not taken to allow for expansion and contraction of the sheets. Where it is not possible to obtain the necessary expansion and contraction through curves of the adjacent sheets, it is then necessary to provide some method to take care of expansion and contraction. In this case all sheets and patches will be corrugated, as shown in Fig. 1. A strain on a weld, especially where the new sheet is welded to an old sheet, which is generally the case, is particularly harmful as the old sheet will not stretch as much or as uniformly as the new one.

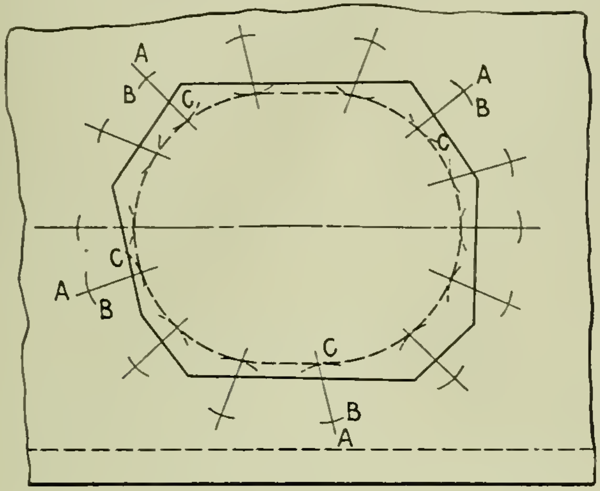

Fig. 2—Method of Laying Out Patches for Welding

12.

When fitting corrugated sheets or patches, they should be bolted securely in place and when they extend to the mud ring good drift pins should be inserted in the mud ring holes so that the sheet cannot move upward due to the contraction as the contraction should be taken from the corrugation. Bolt the sheets at the welding end as usual. That is to say, insert a ⅝-in. bolt through every fifth staybolt hole and screw in a staybolt from the outside between each of the ⅝-in. bolts, thus holding the sheets in line. Then insert small wedges between the welding edge spaced about 14 in. apart to keep the sheet from pinching together during the welding.

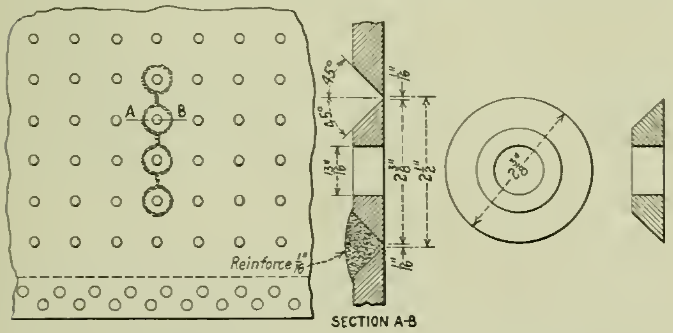

Fig. 3—Method of Welding Cracks Through Staybolt Rows; Gas

13.

Where side sheets are to be welded at the ends it is necessary to remove the adjacent row of staybolts to the edge of flange of door or flue sheet before welding is commenced. It is also advisable to remove all staybolts adjacent to welds after the welding is completed.

14.

When welding corrugated sheets or patches with the oxy-acetylene method the following instructions are to be carried out; with every 12 in. of welding completed, the operator will stop and heat a line 1 in. wide through center of corrugation to a red heat and continue this until the weld is finished.

15.

No fire box welds should be reinforced more than 1/16 in. as too great a reinforcement is injurious to a weld due to over-heating when in service.

16.

For firedoor patches when collars are to be welded they should be cut out at a point where at least one row of staybolts is in the patch and as nearly round as possible. When the patch is cut out at a point 6 in. or more from the firedoor edge it should be corrugated all around as shown in Fig. 5. It will not be necessary to corrugate if the patch is cut out less than 6 in. from the door hole. When firedoor patches are extended to the mud ring and 6 in. or more from the firedoor edge the patch will be corrugated all around but where patches do not extend to 6 in. from the firedoor edge, it will only be necessary to corrugate both sides of the patch from a point about half way from the firedoor down to the mud ring.

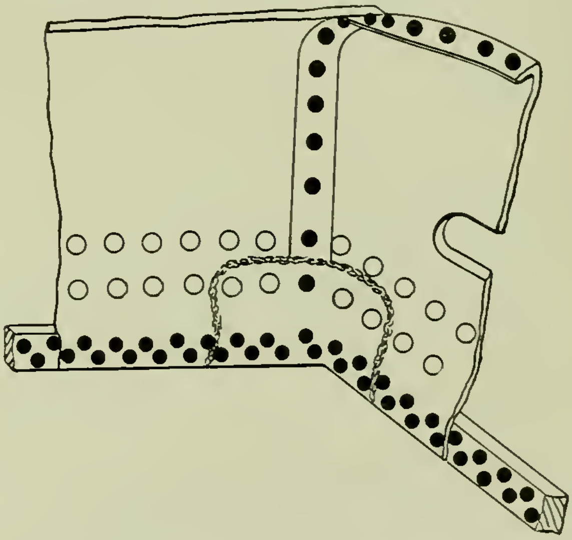

Fig. 4—Application of Mud Ring Corner Patches; Gas or Electric

17.

The welding of cracks in side sheets, door sheets, firedoors, crown sheets, bottom and top of flue sheets should never be attempted as such attempts have been a source of much trouble and many engine failures. However, it may be considered necessary at times to weld certain cracks. This practice should be resorted to only in occasional emergency cases and then such work should be classed as strictly temporary and be corrected at the first opportunity. It is, of course, known that such work as welding cracks in the barrel of a boiler, welding over staybolts and welding staybolts is strictly against the law and will not be allowed at any time.

18.

When it becomes necessary to weld seams that have given away, such as those between door or flue sheets and side sheets, the rivets should be removed and the outside of the fire side lap should be cut off through the center line of rivet holes. Do not cut the side sheet and see that it is cleaned thoroughly before welding is commenced. Weld the holes solid and lap weld sheets.

19.

Fitting, Preparing and Welding Fireboxes

For fitting, preparing and welding a firebox without removing the back end the firebox should be set up on the floor with all staybolts and mud ring rivet holes drilled, except mud ring corner holes, which should be drilled after the sheet is up and welded.

The welding edge should be chipped to a 45-deg. angle and chipped on a straight line so as to insure a uniform opening of ⅛ in. between the welding edges.

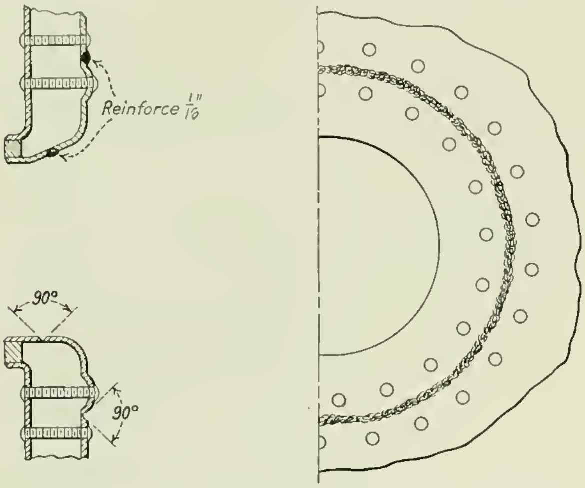

Fig. 5—Butt Welded Fire Door Patch; Gas or Electric

The lower portion of the sheet from a point about 14 in. from the bottom of the flue and door sheets should not be chipped until the box is in place and the mud ring corners in place.

Bolt the sheet securely in place, being sure that there is a uniform opening of ⅛ in. all around the welding edge.

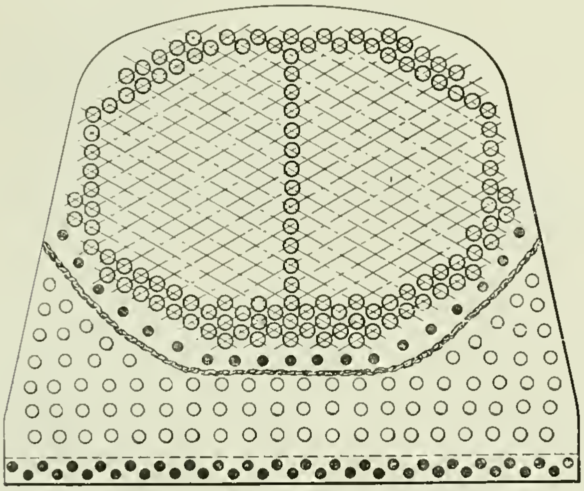

Fig. 6—Method of Applying New Tube Sheet Section; Gas or Electric

Use a ½-in. drill and drill holes spaced about 14 in. apart, using ½-in. machine bolts with clamps made of boiler plate ½ in. by 2 in. by 4 in. Use one of these pieces on each sides of the sheet, being sure that all bolts are drawn tight.

Rivet the top of the flue sheet to a point not less than 12 in. below the center of the crown; start welding at a point about 10 in. below the rivet and weld up to the rivets. Then drop down 10 in. and weld up to the end of the previous weld. Continue this operation until completed, removing clamps when necessary. Weld the entire door sheet.

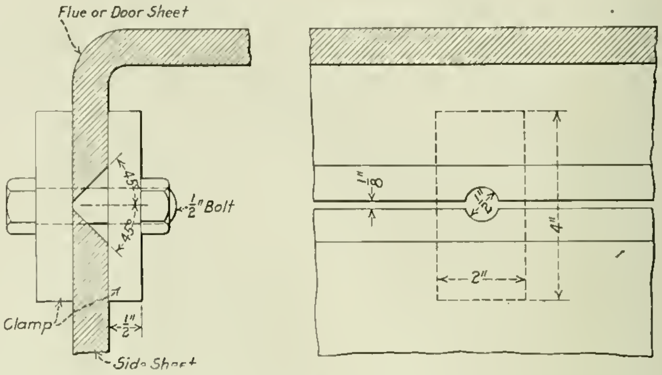

Fig. 7—Clamp for Holding Fire Box Sheets in Line when Welding

Examples of Boiler Shop Welding

The method of making corrugations for side and door sheets to allow for expansion is shown at *A*, Fig 1. The corrugation for patches is more pronounced and is shown at *B* in the illustration.

In laying out patches previous to welding it is sometimes difficult to cut them accurately unless some such method as the following is used: After the sheet has been cut out and beveled, the lines *A*, Fig. 2, are scribed as shown. With the dividers set at about 6 in. arcs *B* are scribed from the edge of the bevel. When the patch is ready to lay off for size, it is bolted firmly into place, as shown in Fig. 2. The lines *A* are then scribed back on the patch a short distance. With the dividers set at the same distance used before and with the intersections of lines *A* and *B* as centers, arcs *C* are scribed on the patch. Where these arcs intersect lines *A* are points on the edge of the patch. A smooth curve is drawn through these points and the patch cut to the line. It can then be beveled and welded in place in accordance with the standard practice at local shops.

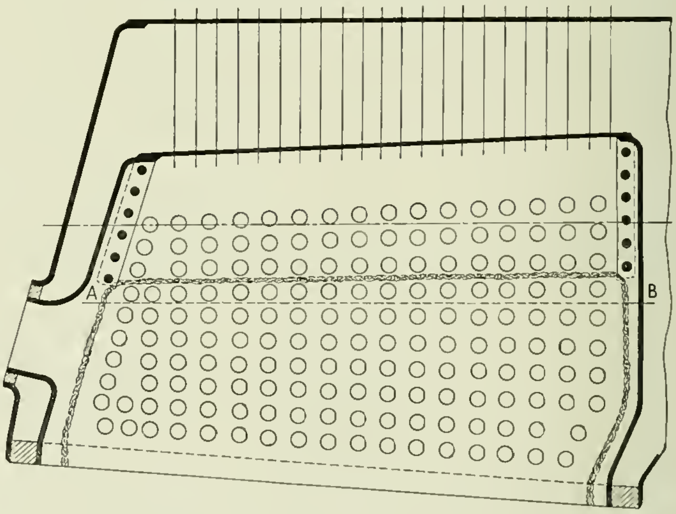

Fig. 8—Side Sheet Application; Gas or Electric

Boiler plates cracked through staybolt holes are a common occurrence and often give much difficulty before repairs can be made One method of overcoming this difficulty is illustrated in Fig. 3 in which a new circular section of boiler plate drilled and beveled as shown at the right is applied by welding. It will be noted that the bevels are cut at an angle of 45 deg. and the weld is reinforced by adding 1/16 in. to the thickness of the original plate.

An interesting example of the method of applying mud ring and corner patches is shown in Fig. 4. This operation can be performed either by gas or electric welding, but the caution should be observed of never laying out the patch so that the weld will come lower than between the first and second rows of staybolts above the mud ring.

The method of applying a butt-welded firedoor patch is shown in Fig. 5. The corrugation to allow for expansion is shown and, as in the previous instance, the patch is beveled to an angle of 45 deg., the weld being built up an additional 1/16 in. for reinforcement.

When constant reworking of tubes and flues has damaged the flue sheet bridges, but the lower portion of the sheet is in good condition, the method of repair by welding in a new top section is shown in Fig. 6. This method effects quite a saving in time since the top flue sheet section can be more quickly laid out and formed, and the labor of cutting and reapplying staybolts in the lower section is eliminated. If any difficulty is experienced in bringing the edges of the new and old plate in alignment previous to welding, a special clamp, as shown in Fig. 7, can be used.

One of the most successful uses of welding in boiler work has been in the application of side sheets and half side sheets. The application of a full side sheet is shown in Fig. 8 with the corrugation for expansion along line *A-B*.

Characteristic Heat Treatment Curves*

BY ALBERT M. PORTEVIN AND PIERRE CHEVENARD

At the outset of a quantitative investigation of the influence of cooling, it should be pointed out that recent researches on the hardening of steel have led to the establishment with, in this instance, great accuracy, of the mutual relationship which exists between the two fundamental factors of all heat treatment—the temperature of heating and the rate of cooling.

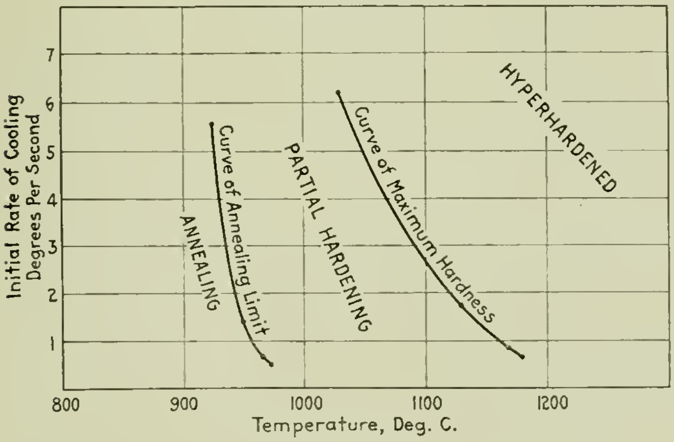

Fig. 1—Characteristic Heat Treatment of a Typical High Speed Steel: C = .40; Cr = 4.5; Tu = 18

The final condition being a function of these two variables, it is easy to see the interest attaching to plotting a graphic representation of the result of a treatment by taking, for any given steel, these variables as co-ordinates. This method leads, as the authors will presently show, to the establishment of what they have termed the "characteristic curves" of the heat treatment of the steel in question.

Characteristic Curves

By varying simultaneously the initial temperature of heating and the rate of cooling, it is possible to plot (Fig. 1) the geometrical area of the various characteristic limits of the different states in terms of temperature and rate of cooling, taken as co-ordinates. By these means are obtained the "characteristic curves of heat treatment for the given steel." They comprise more particularly:

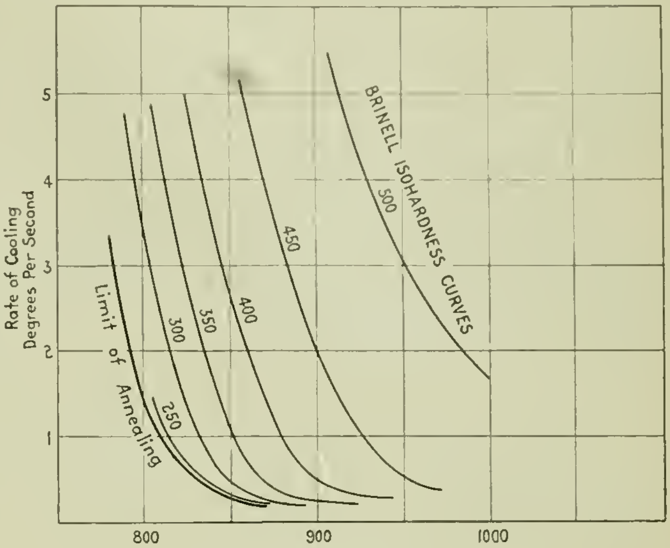

Fig. 2—Curves Summarizing Results of Tests

1. The curve of annealing limit for each rate of cooling. This curve separates the annealed states, devoid of martensite, from the hardened states, containing martensite. It is therefore the curve of the annealing limit and rigorously defines the hardening capacity of the steel.

2. The curve of maximum hardness, or of the maximum amount of martensite. This is the curve of maximum quenching, which similarly marks the limits between the partially hardened and the partially hyperhardened states.

The diagram of the characteristic curves summarizing the whole of the determinations arrived at in experiments conducted by the authors is given in Fig. 2. It comprises the curve of the limit of annealing, or curve of the critical rates of hardening, separating the region of the annealed states from that of the hardened states; and in the latter region the succession of curves of isohardness corresponding with the values of Brinell hardnesses varying from 50 to 500.

As has been said, the isohardness curves relating to hyperhardening were not taken, so that this diagram does not exhibit the curve of maximum hardness. Moreover, it cannot be hoped to collate into one plan and on one common scale the entire appearance of characteristic curves, given the considerable range of cooling rates obtainable. It is necessary to limit the inquiry, in the first instance, to the most useful and most serviceable portion, for each steel. Even within these limitations the diagram of characteristic curves furnishes a collection of facts as to heat treatments incomparably superior to the often somewhat elementary collection of numerical data hitherto accumulated in connection with the heat treatment of steels. Very often the basic considerations relating to mass and rate of cooling cannot be deduced from these observations, or expressed numerically, so that it becomes impossible to foresee what modifications may be required when the size of the pieces or the nature of the cooling medium is changed.

Numerous and important researches have now supplied data as to the cooling capacity of liquids and gases, and in order to apply them to practice there should now be plotted,

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*From a paper read before the September 5-6, 1921, meeting of the Iron and Steel Institute.

with no less accuracy, and for each type of steel, the curve showing the relationship between the rate of cooling and the effect of treatment, taking into consideration more particularly, the part played by the second of the fundamental variables—the temperature of heating.

It is to the questions raised by the latter problem that the plotting of the characteristic curves can supply answers, as they combine, in a readily utilizable form, all the data furnished as to heat treatment and are the only means of ascertaining, with any degree of precision, the hardening capacity of a given steel.

Hydraulic Rod Bushing Press

BY J. H. HAHN

Asst. Machine Shop Foreman, Norfolk & Western, Portsmouth, Ohio

A simple and effective hydraulic rod bushing press which can also be used for applying and removing driving box crown brasses is shown in the illustration. This press develops a pressure up to 70 tons and can be easily and cheaply constructed in the average machine shop, having been developed on the Norfolk & Western for use at several roundhouses and shops on the system.

A complete set of rod brasses for a 2-6-6-2 engine has been applied with the press illustrated in 35 min. Crown brasses and motion work bushings also can be applied. A pressure of 70 tons is obtained but, if desired, the cylinder can be so designed as to give a pressure of more or less than 70 tons, depending upon the requirements. Another feature of this type of press is the small amount of floor space required, as the operating cylinder and practically all piping are located under the floor.

Hydraulic pressure is supplied by a 9½-in. Westinghouse compressor, usually located at some convenient point on a bracket on the wall near the press. The air cylinder is bushed to 3¾ in. by applying a brass or cast iron bushing milled with suitable ports. The valves should be given a little more lift to handle the volume of water necessary to operate the press. Operation of the press requires no special effort as an apprentice can readily operate it after a few minutes' instruction in manipulating the various valves. A safety valve is provided to take care of any excess pressure and a pressure gage mounted on, or connected to the pressure system at any convenient point, indicates the pressure used in applying the bushings.

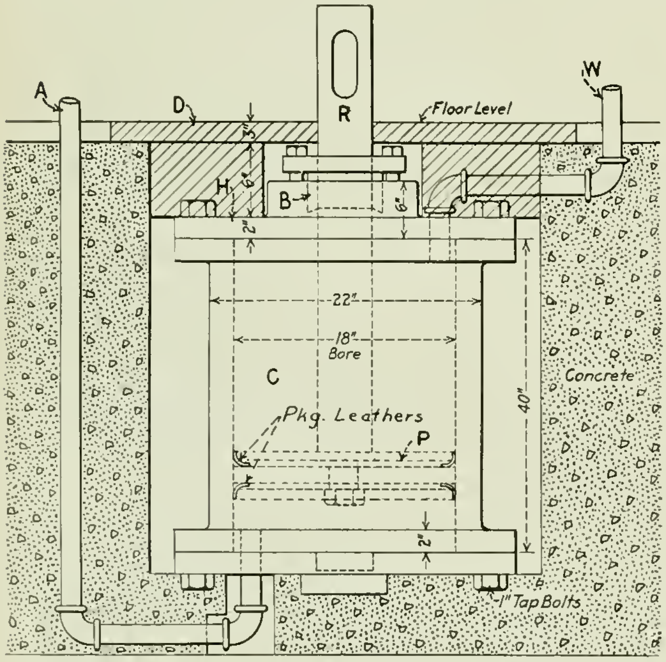


Fig. 1—General Arrangement of Hydraulic Rod Bushing Press

Referring to Fig. 1 the general dimensions of the cylinder and its method of placement in a concrete pit under the floor is plainly indicated. Cylinder head *H*, also the bottom cylinder head, is fastened to cylinder *C* by means of 12 one-inch tap bolts. It will be noted that piston *P* is equipped with double packing leathers, set in reverse directions and leaks by piston rod *R* are prevented by means of packing in stuffing box *B*. Since the press operates on the down stroke, cast iron plate *D* is provided with projections as shown to transmit the pressure from the work to the cylinder head *H*. *A* and *W* are the air and water pipes to the bottom and top of the cylinder respectively.

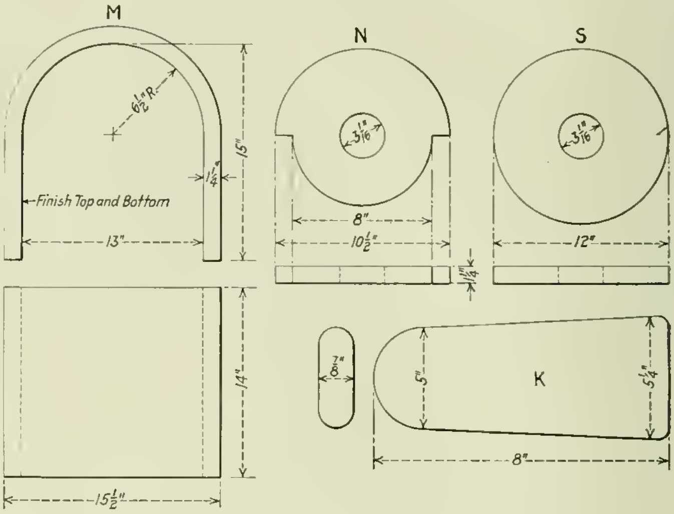
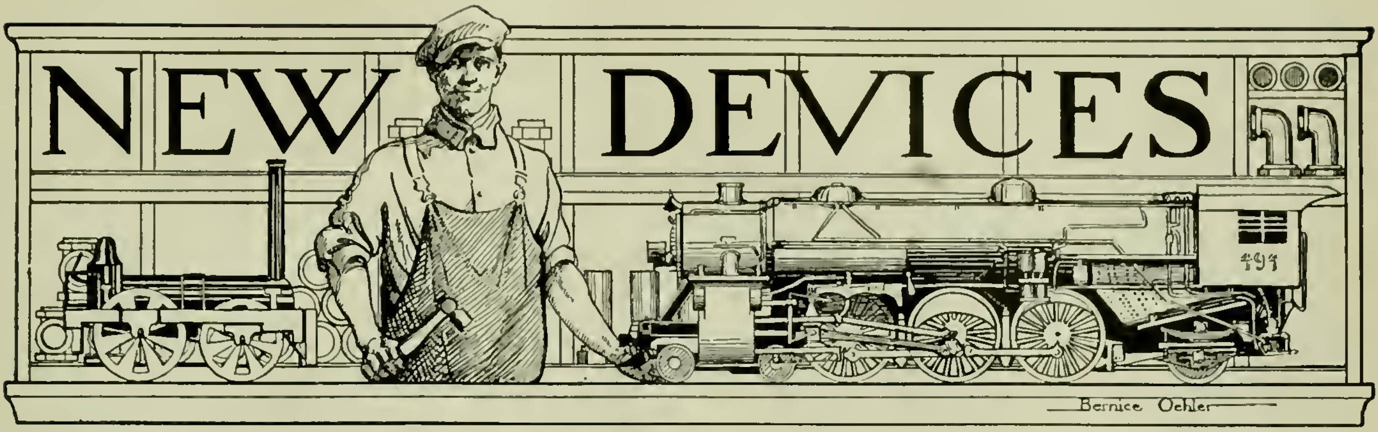


Fig. 2—Horseshoe, Plates and Taper Key Used with Hydraulic Press

Method of Operation

When applying a rod bushing in a side rod the bushing is started and a circular plate *S* (Fig. 2) applied over the end of the piston rod which has been raised by means of air pressure through pipe *A*. The proper key *K* is then applied and, with the air exhausted from under piston *P* the compressor is started and hydraulic pressure transmitted through pipe *W* to the top of the piston. This forces the piston downward and applies the bushing with a pressure indicated by the gage.

After the brass has been applied, the compressor is stopped and a by-pass valve in pipe line *W* (not shown in the illustration) opens to allow water on top of the piston to flow into the drain pipe. Opening an air valve (not shown) in line *A* will then force the piston upward and expel water above the piston through pipe *W* and the by-pass valve to the drain pipe. Sets of plates and keys are made in 6, 8, 10 and 12-in. sizes as shown at *S* and *K*, Fig. 2. For removing rod brasses the rod is blocked up a distance slightly greater than the bushing width and a plate of suitable size used to force the bushings down through the rod. For removing driving box crown brasses a horseshoe plate made of 1¼-in. stock is bent as shown at *M*, Fig. 2. The box is mounted on the horseshoe and a flat plate *N* of suitable size is used to press the old brass out of the box, also using a key as heretofore explained. The horseshoe *M* is not needed when applying the crown brasses to the boxes as the latter can then be placed directly on the cast iron plate and while in this position it is impossible to press the brasses in the box too far as sometimes happens with other types of presses. Plate *N* also is made in different sizes to suit the various types of driving boxes and is used in both cases whether applying or removing brasses. A 24-in. by 36-in. reservoir is used as a storage drum to supply air for raising the piston.



New Planer Designed for Maximum Service

THE necessity of reducing the cost of planer work by conserving every possible moment of the operator's time was the guiding thought behind the design of the new Maximum Service Planer made by the G. A. Gray Company, Cincinnati, Ohio. The novel features incorporated in its design are all intended to increase the production capacity of the machine and provide maximum ease of operation.

The method of adjusting the new Cantslip positive feed is by turning a knob at the operator's end of the rail until the required feed is indicated on the graduated dial. A partial turn of the wrist gives any feed from .01 in. to 1 in. in steps of one-hundredth of an inch. The feed dial is automatically locked as soon as the fingers are removed from the knob.

As will be seen in Fig. 1 the feed mechanism for the rail heads is mounted on the end of the rail, that for the side head is mounted on the head itself, and thus is always within convenient reach. Rail head and side head feeds are entirely independent so that one can be changed without affecting the other. Feed changes may be made while the planer is running, and changing the feed is said to be as simple as turning a door knob.

The rapid traverse embodied in these planers is applied to the side heads as well as to the rail heads. To move a head the operator simply shifts one lever. Shifting the lever disconnects the feed for that particular head, engages the rapid traverse mechanism and starts the small motor in the proper direction. Moving the lever back to neutral throws out the rapid traverse clutch, stops the motor and re-engages the feed. It is not necessary to make use of a separate starter to start the motor, nor does the motor run while not actually in use. No part of the rapid traverse mechanism is in motion unless a head is actually being moved.

As the traversing mechanism is entirely separate from the feed mechanism, one head can be rapidly set for the next cut while the other head or heads are still feeding. Throwing in the traverse mechanism automatically disconnects the hand cranks so that these do not revolve and endanger the workman. The levers for actuating the rail

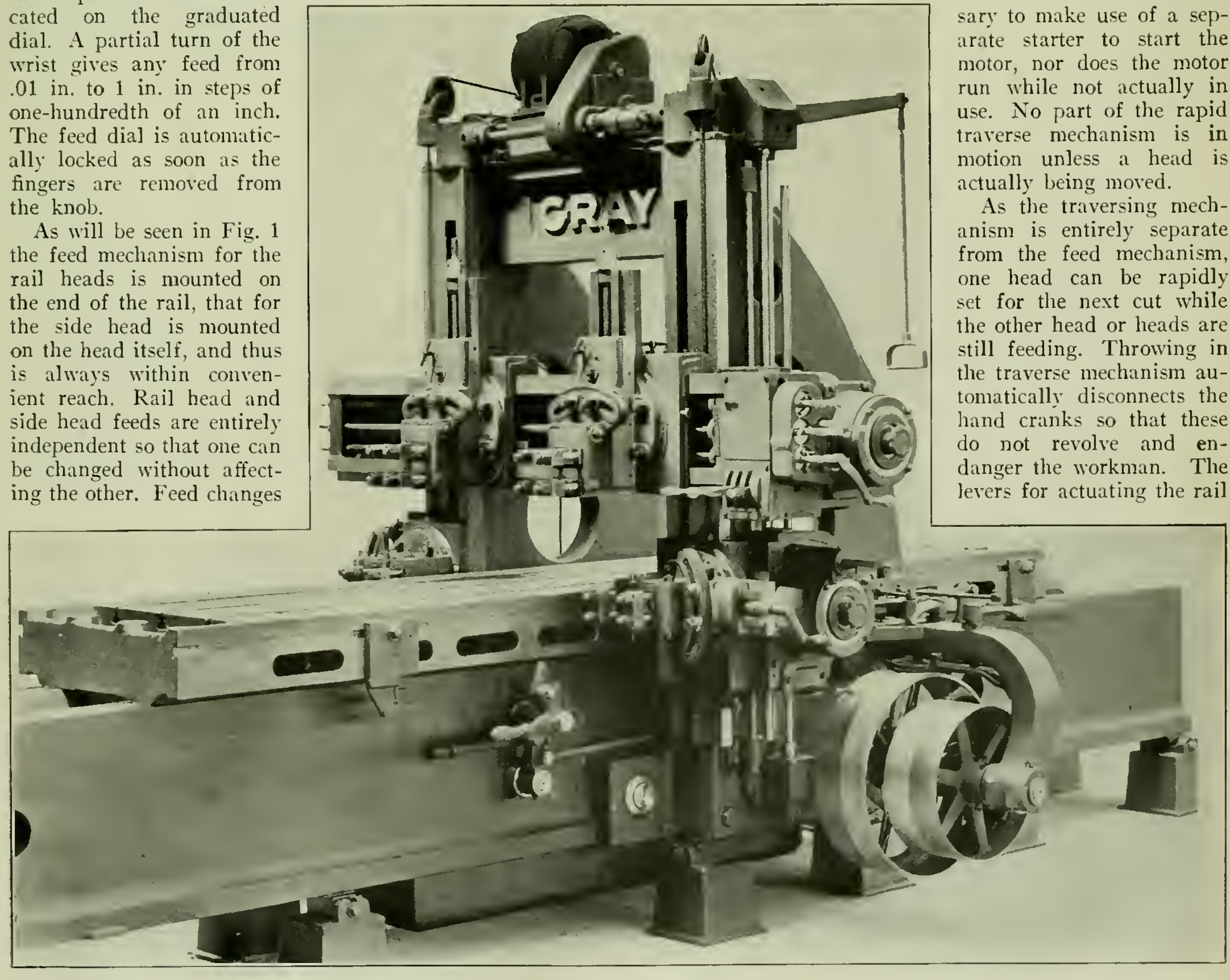


Fig. 1—Gray Maximum Service Planer Designed for Ease of Operation, Smoothness of Action and Accuracy of Finish

heads are at the end of the rail, the lever for each side head being on the head itself.

Shearing pins safeguard the traverse mechanism in case the rail heads are accidentally jammed together and safety stops obviate the possibility of lowering the side heads too far.

To elevate the rail the operator pushes up a stirrup shown hanging near the end of the rail; to lower the rail he pulls it down. The stirrup is locked in the neutral position and a quarter turn of the wrist unlocks it. As this stirrup is suspended from a universal joint, the operator can stand out in front of the rail where he can see the position of work and tools and set the rail to a line.

The motor that operates the rapid traverse also furnishes the power for the rail setter. One movement engages the elevating mechanism and starts the motor. Bringing the lever to the neutral position disengages the elevating mechanism and stops the motor. Safety stops obviate the possibility of raising the rail too high.

Turning a crank on the operator's end of the rail releases or tightens the clamps that lock the rail to the housings. The automatic adjustment positively insures that the rail is clamped equally rigidly at both ends. The rail is locked to the inside of the housings, an arrangement which greatly stiffens the rail, as it shortens the length of the rail subject to torsional stress (see Fig. 2).

As the lever operating the rail setter is also on the operator's side of the machine the planer hand can release the rail, raise or lower it and reclamp it without moving away from the operating position. Since a large investment is standing idle while the operator is going around a planer to clamp the rail, the saving accomplished by the new method is obvious.

Centralized Control

The net result of these improvements is to bring the control of practically all of the functions of the planer to the operator's usual position. Besides the raising, lowering and clamping of the rail, as described above, he can without moving a step from his position set the feed on rail or the right hand side head; traverse either rail head or the right hand side head quickly by power; set the micrometer collars on the rail screws so as to measure accurately the travel of the tool; and, of course, use the tumbler which controls the movement of the table. In doing these things he is in position to watch his tools and so avoid the probability of serious accidents.

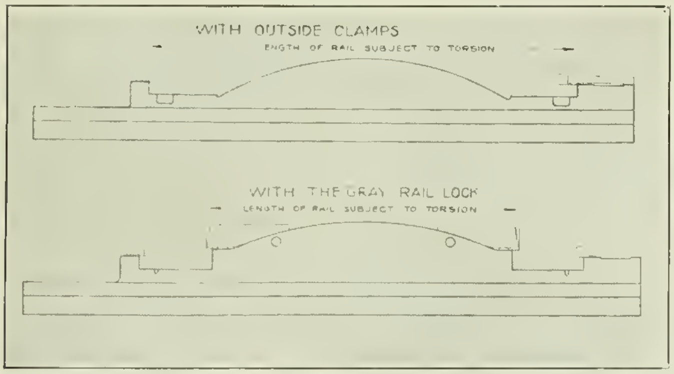


Fig. 2—View Showing Short Length of Cross Rail Subject to Torsional Stress

The bed of the new planer is made full length; that is, the working surface of the table never overhangs, even when taking the maximum stroke. In this way the table is always rigidly supported even when run way out to the front end of the planer for setting up work. By eliminating the table overhang, the wear that otherwise takes place at the ends of the bed is eliminated. The accuracy of bed and table are thus permanently maintained and better work made possible. Incidentally there is no dripping of oil on the floor from overhanging table V's, or unsightly oil pans. Both machine and floor may easily be kept clean.

The table is of box section, with an uninterrupted center wall running the entire length of the table and tying the top and bottom plates rigidly together. This design also prevents endwise springing due to peening action that occurs when heavy work is clamped. The usual transverse walls and posts are also provided. All stop-pin holes open into the cored openings of the table and are easily cleaned from the outside.

All of the driving gears run in a bath of oil so as to minimize wear and prolong their life. An oil pump is direct-connected to the drive shaft and delivers a flood of oil not only to the V's but also to all of the drive shaft bearings. From the pump the oil flows through a filter, thence to a hole in each V at the center of the bed. Each table V has a large oil channel running the full length of the V but closed at the ends. From this large channel the smaller supplementary oil grooves carry the oil to all parts of the bearing surface. By this means the oil supply is kept constant at all points regardless of the relative position of the table, since the pressure is instantly transmitted through the large oil channel.

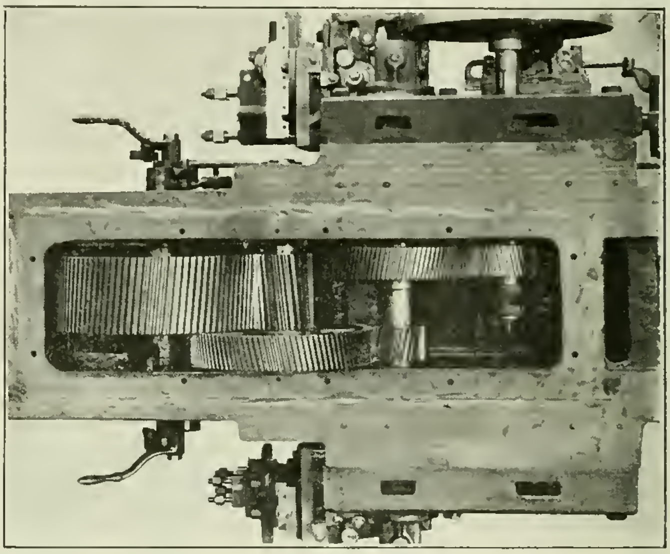


Fig. 3—Involute Helical Gear Driving Arrangement

To simplify the oiling of other parts, central oil wells have been placed on rail and side heads. Oil pipes lead from the central well to the different oil holes, so that the operator merely fills this large reservoir instead of many separate oil cups. This not only saves a great deal of time, but also obviates the danger of overlooking inconspicuous oil holes. From the reservoir the oil is drawn through wicks by capillary attraction so that only clean oil reaches the bearings.

New Geared Drive Arrangement

Probably the most important part of a planer is the gearing which drives the table. The Gray maximum service planer is provided with a new system of gearing in which advantage is taken of a number of properties of involute helical gearing to produce a drive of unusual smoothness and power.

A properly designed pair of helical gears is stronger than a pair of spur gears of the same pitch and width of face. In addition to their greater strength, helical gears give continuous pitch line rolling, since there is always some point on the pitch circle where the mating teeth are in contact. Furthermore, in the case of helical gears more teeth are in contact which in itself increases the strength and smoothness of action of the gearing.

Gray maximum service planers have helical gears throughout (Fig. 3), and advantage is taken of end thrust to cause the end thrust of the bull gear and its pinion to counteract the side thrust of the tools when cutting. Moreover, the diameters and helical angles of the remaining gears of the train are so proportioned that their end thrusts largely balance one another. Bronze thrust collars, provided with forced lubrication, take the slight residual end thrusts. Particular attention is called to the helical table rack which is of unusual width of face, giving great strength. The end thrust of the bull pinions opposes and compensates for the side thrust of the cutting tools when they are being fed away from the operating side of the machine, a condition which obtains at least 90 per cent of the time. As the tool pressure increases, the power required to drive the table and the resultant balancing thrust of the bull pinion also increases proportionately. This equalizes the pressure and wear on the two sides of the V's.

For the convenience of the operator, planer work is usually placed close to the operating, or so-called right hand side of the machine. It is therefore desirable that the line of action of the driving force should be placed slightly toward the right hand side of the machine, so that the lines of action of the cutting tool and the driving force shall coincide as nearly as possible. The rack is accordingly so placed.

The table rack is cut with a low pressure angle, thus greatly reducing the tendency of the bull gear to lift the table and making hold down gibs or other devices for preventing this action unnecessary. In order to obtain maximum torsional stiffness, reduce the strain on the shafts, and insure concentricity of the gears, the gears are not keyed to the shafts but are pressed on and keyed to the pinion bosses. The gear teeth are then cut, thus insuring not only rigid and permanent connection, but as nearly as may be absolute truth of mounting.

To insure correct tooth action, teeth of true involute form, cut by a generating process, are employed. This special form of tooth is distinguished by its full length, low pressure angle, short arc of approach and very long angle of action. The last feature greatly increases the number of teeth in simultaneous contact, reduces the specific pressure at the lines of contact, gives large and strong pinions, great smoothness of action, long life and quiet action, and produces work of great smoothness and accuracy of finish.

Welding Sets for Medium and Heavy Duty

Two types of gasoline engine-driven arc welding sets, one for medium or intermittent duty, and the other for heavy duty, have been developed recently by the General Electric Company, Schenectady, N. Y. Both outfits are well adapted to industrial plants where the work to be done is located in odd places and is not sufficient to warrant the installation of permanent equipments. Their particular field, however, is in places where electric power is either unavailable, inconvenient or costly to bring to the work, as at outlying points on railroads.

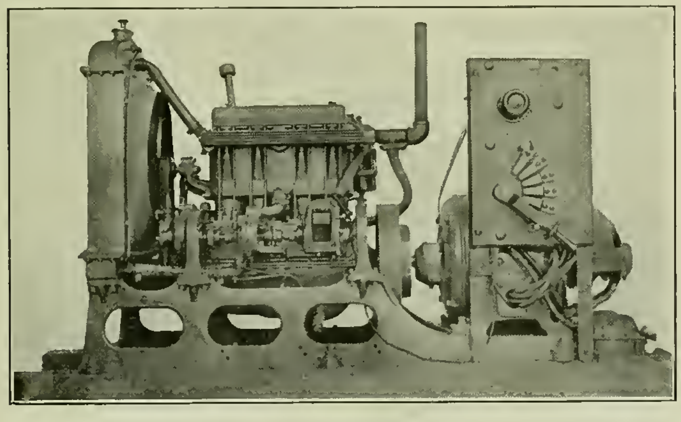


Fig. 1—General Electric Arc Welding Generator for Intermittent Duty Driven by 20-Hp., Four-Cylinder Gasoline Engine

The medium duty equipment shown in Fig. 1 was designed particularly for intermittent duty. The generating unit consists of a type WD 10-4 kw., 1200 r.p.m., 60/20 volt, 200 ampere generator, directly connected by a flexible coupling to a Matthews, Model F, four-cylinder, four-cycle, 20-hp. gasoline engine. The engine, radiator, generator and welding panel are assembled on a rigid cast iron base which in turn is mounted on wooden skids. The set is 86 in. long, 28 in. wide, and has a net weight of about 2,000 lb., making a light and compact affair to move about. The gasoline engine used with this outfit has been especially adapted to the requirements of intermittent welding service. It is of the overhead valve type, the cylinders being cast in block with the upper half of the crank case. The lubrication is a combination of splash and force feed, except where special conditions require the addition of a pump which is driven by the accessory shaft.

The generator is self-exciting and regulating, giving practically constant energy throughout the working range. It gives a no load, or striking voltage of 60 which automatically decreases to the proper welding voltage (usually 18 to 20 volts) when the arc is struck. It is driven at a speed of 1200 r.p.m., has a normal output of 4 kw. and delivers a maximum working current of 200 amperes. The panel carries the generator field rheostat and series field dial switch by which the current can be adjusted from 200 to 75 amperes in 25 ampere steps. A reactor choke coil mounted on the set and connected in the welding circuit protects the generator from current surges.

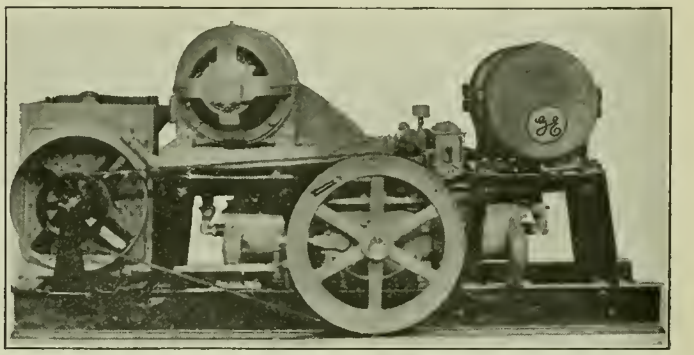


Fig. 2—Heavy Duty, Arc Welding Set, Driven by 20-Hp., Two-Cylinder Kerosene Engine

The heavy duty equipment (Fig. 2) can be arranged to supply either one or two welding circuits. It consists ordinarily of a 20-hp. two-cylinder opposed Reliable gasoline engine, a type WD 9 generator and welding panel, the whole mounted on a welded structural steel base with a net weight of 2,400 lb. for the single operator equipment and 3,200 lb. for the double operator equipment.

The gasoline engine is designed for continuous operation at rated output. Careful balancing practically eliminates vibration and the horizontal cylinder and relatively small flywheel makes possible a compact assembly with the rest of the outfit. It is said to run on kerosene, distillate, gasoline or natural or artificial gas, with a fuel consumption per brake horsepower not exceeding one pint of kerosene, distillate or gasoline, 10 to 12 cans of natural gas, or 17 to 22 ft. of average illuminating coal gas.

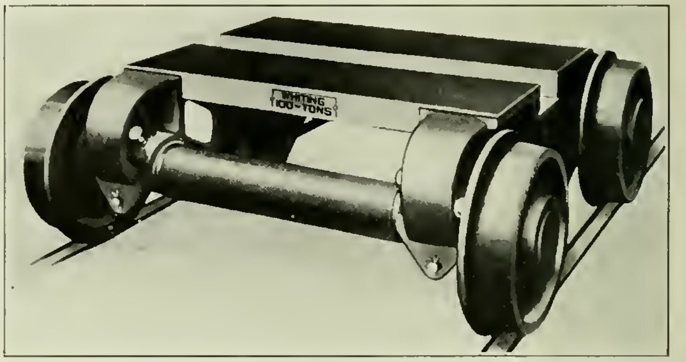
The generator is driven by a silent chain running in oil, and except for the speed, its characteristics are similar to the WD 10 generator which forms part of the medium duty outfits. The speed is 1750 r.p.m. instead of 1200 r.p.m. and the motors differ somewhat in the windings because of the difference in speed and service requirements. An ammeter is mounted on the panel of each heavy duty equipment, but in other respects they are identical with the medium duty sets.

One Hundred-Ton Locomotive Shop Truck

WHERE the Whiting hoist is used for wheeling and unwheeling locomotives it is customary to provide some form of four-wheel truck applied to the rails under the front and back ends of the locomotive for its subsequent movement to the place where repairs are to be made. It is essential that these trucks be of extremely rugged construction and so designed as to eliminate friction as far as possible and make movement of the locomotive reasonably easy. The truck shown in the illustration has been developed primarily for this purpose by the Whiting Corporation, Harvey, Ill., but may also be used to advantage for transferring unwheeled locomotives where cranes are employed for the purpose of unwheeling.

The sides of the truck are heavy steel castings connected by structural members to form a rugged unit. The frame is mounted on a steel axle provided with heavy steel wheels. Special attention has been paid to the design of the bearings, which are of liberal size and lubricated in such a way as to reduce friction as much as possible. This is an important point.

The truck is designed for a load of 100 tons with a liberal factor of safety and its rugged construction makes it of special value for the purpose for which it was designed.



Whiting 100-Ton Locomotive Shop Truck

Hose Dismantling and Assembling Machine

THE machine illustrated has been designed for the single purpose of dismantling and assembling air, signal and steam hose used in railroad service. It is a self-contained, air-operated machine, which needs no special foundation and can be set up on the shop floor, under a shed or in any location convenient to an air line with from 85 to 100 lb. pressure.

The machine consists of body *A* (Fig. 1), mounted on three pairs of legs, and equipped with three cylinders; cylinder *B*, operating the special shear knives *C* for cutting clamp bolts; the main cylinder *D* for operating cross-heads *E* and *F* which carry the dismantling and assembling tools; and cylinder *I* (Fig. 2) in the rear of the machine for operating the head *G*. This head clamps old hose for stripping (Fig. 3) and with the trough jaws *H* and *J* (Fig. 4) holds new hose in alinement for assembling. A bumper box which ab-

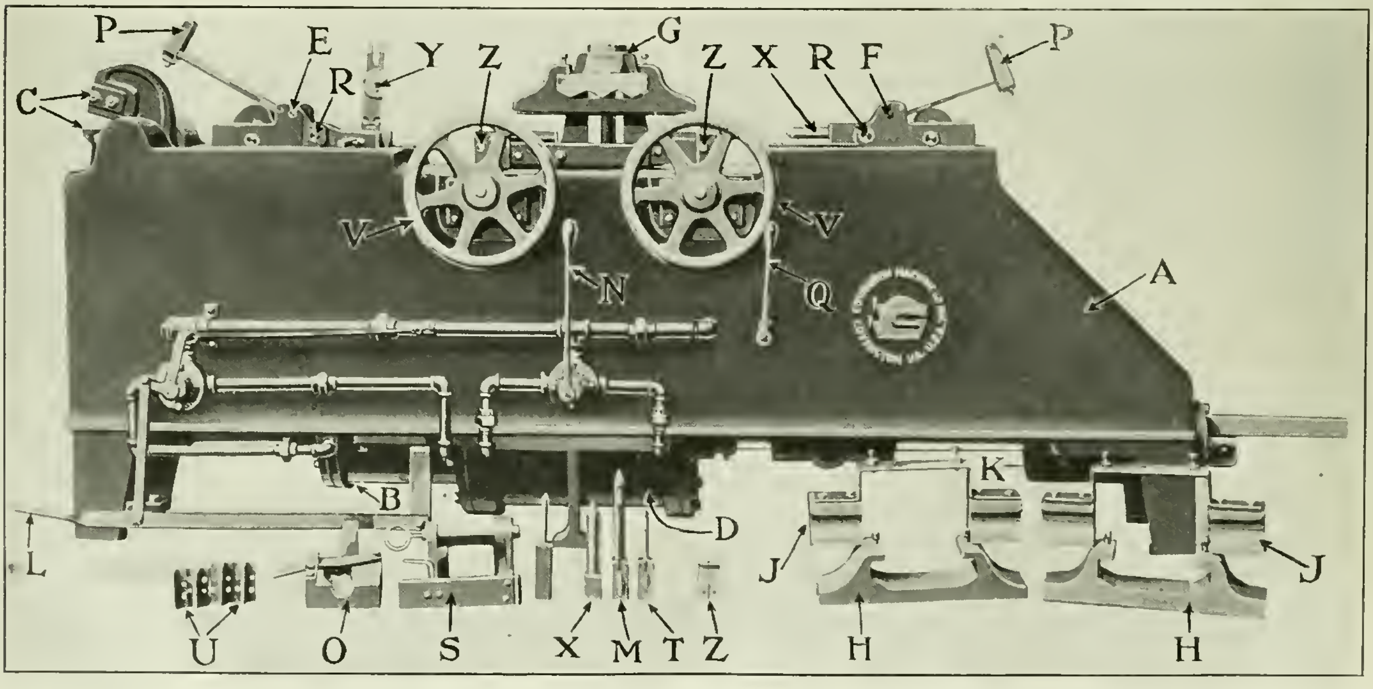


Fig. 1—General View of Covington Machine for Dismantling and Assembling Air, Signal and Steam Hose

sorbs the shock when stripping old hose is shown at *K* (Fig. 1).

With this machine, which is heavily built for hard and constant service, nipples, couplings and clamps are stripped from old hose and assembled on new hose over and over again. No fittings are injured in any way, the only loss being the clamp bolts which are cut in dismantling, and these bolts, due to rust, are scrap in any case.

The Dismantling Operation

The operation of the machine for stripping old hose is as follows: Referring to Fig. 1, clamp bolts are first cut under special shear knives *C* without injury to hose clamps, the valve controlling this operation being operated by the foot treadle *L*, thus leaving both hands free to hold the hose. On a test, one operator is said to have cut both clamp bolts from 140 hose in 20 min.

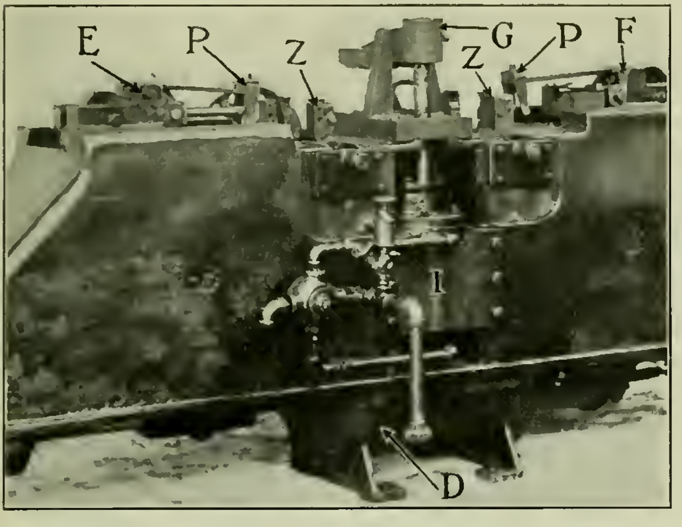


Fig. 2—Rear View Showing Cylinder Which Operates Hose Clamping Head

After cutting the clamp bolts, the nipple end of the hose is placed over the nipple puller *M*, which can be placed in crosshead *F;* the operating lever *N* is moved to the left, bringing crossheads *E* and *F* toward the center of the machine. The coupling end of the hose is then dropped into the coupling puller *O* placed in crosshead *E;* both clamp pullers *P* are dropped down over the hose in back of the clamps; the operating lever *Q* for the clamp cylinder is moved to the right clamping the old hose between serrated head *G* and a serrated block on the frame, as shown in Fig. 3. The separating lever *N* is moved to the right admitting air to the cylinder *D;* both crossheads draw back at the same time, pulling out both nipple and coupling together with the clamps without injury to fittings or clamps. The whole operation requires less time than it takes to describe it and one operator is said to have dismantled 140 hose in 40 min.

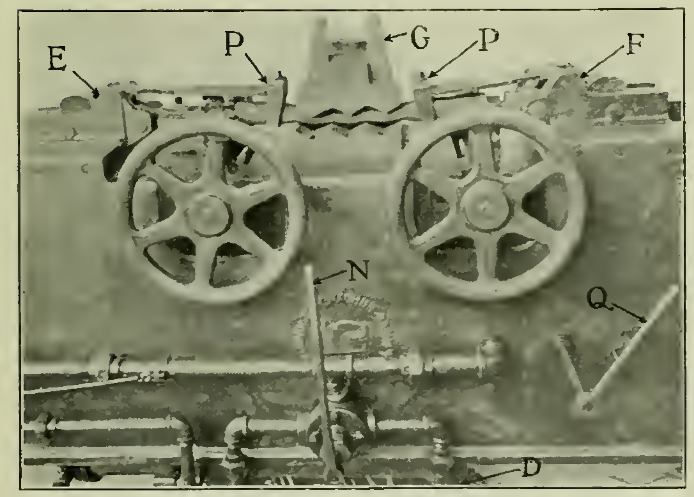


Fig. 3—Machine Equipped for Stripping Clamps and Fittings

The operation of stripping air, signal or steam hose is exactly the same, the changes in tools for different hose being made very quickly. The pins *R* (Fig. 1) being pushed out, the tools already in the crosshead can be removed and others substituted.

Air and signal hose are handled by the same coupling puller; for steam, the coupling puller *S* is used. The same nipple puller *M* for air and steam hose is used; for signal hose, the one at *T* is substituted. Many hose are cut or pulled in two parts making short ends. These are handled as easily by the Covington machine as whole hose, by using the short end pullers *U*.

Assembling New Hose and Fittings

In assembling, special trough jaws *H* and *J* (Fig. 4) are placed over the serrations on the clamp head *G* and clamp block on the frame. A new hose is laid in this trough and the operating lever *Q* pushed to the right, bringing the head *G* with trough *H*, down on block *J* holding the new hose straight and in line without any clamping which would possibly injure the hose.

The hose clamps are placed in position, the nipple centered and held on plug *X* and the coupling placed in the fixture *Y*. The ends of the fittings are swabbed with rubber cement as usual, then the operating lever *N* is moved to the left, bringing both crossheads *E* and *F* towards the center of the machine, forcing both fittings into the hose at the same time. Due to the centering devices for both the hose and fittings, no injury is done to new hose. All heads are then released and the hose clamps brought together by means of the handwheels *V* and jaws *Z* (better shown in Fig. 2). The clamp bolts are then put in place and nuts screwed on, thus completing the assembling operation.

The speed of the machine depends largely on the operator's willingness to work. On a test, an operator cut the clamp bolts and dismantled 140 air hose in 60 min. Out of the 140 hose, 15 short ends were pulled due to bursted hose pulling in half, necessitating using the short end puller. The time taken to cut the clamp bolts from 140 hose was 20 min.; to dismantle the 140 hose, 40 min. In the pile of couplings, nipples and clamps not one was injured in any way, but all were ready to be cleaned and assembled into new lengths of hose.

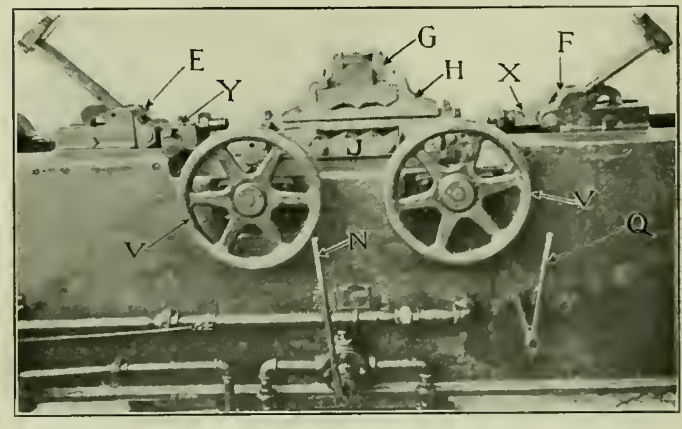


Fig. 4—Arrangement for Assembling Hose, Clamps and Fittings

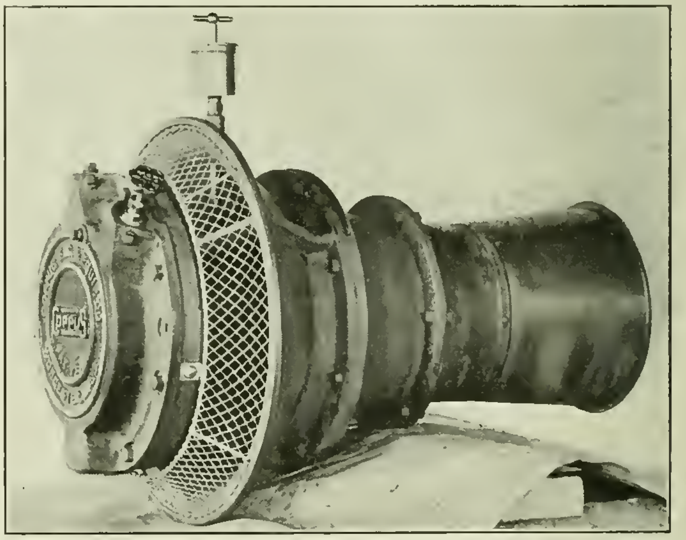
In the assembling test one operator took the new lengths of hose, put on clamps, forced the coupling and nipple in the new hose, squeezed up the clamps, inserted clamp bolts and put on the nuts of 30 air hose ready for service in 60 min. The time taken to assemble each hose ready for clamp bolts averaged 30 sec., and the balance of the time, or 1½ min. for each hose was taken in squeezing up clamps, putting in bolts and running up the nuts. Most of the time is consumed in putting in the clamp bolts on the assembling operation.

The dismantling can be speeded up when great quantities of hose are handled by having one operator on the shear end cutting clamp bolts, while another operator is stripping the hose, as each operation is independent. This, however, is hardly necessary since, as shown by the test, the rapidity is such that one man can usually handle, unassisted, all the work of this nature in the average shop. The statement is made that any workman of average ability can become an experienced operator within ten days. All operating levers and handwheels are in easy reach and convenient for the operator. The Covington hose dismantling and assembling machine is manufactured by the Covington Machine Company, Inc., Covington, Va.

Propeller-Type Blower of Novel Design

THE screw blade, propeller-type blower, shown in the illustration, is made by the Coppus Engineering & Equipment Company, Worcester, Mass., the principal new feature of this design being a stationary guide vane beyond the propeller so arranged that the air current on leaving the propeller is radially subdivided by the individual guide vane blades and taken up by them without shock. These blades have a curvature increasing in the direction of rotation of the propeller and concentrate the air current, giving it a further acceleration inside of the stationary guide vanes so that a considerable part of the pressure is obtained in the latter. The end thrust is therefore mostly taken by the stationary guide vane casing.

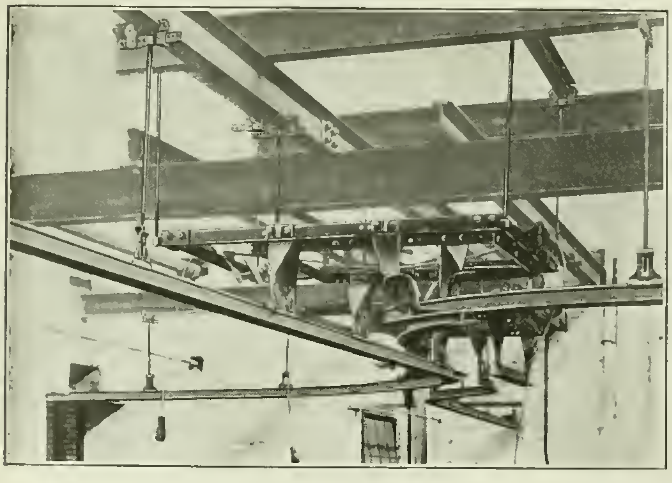
Moreover, the delivery of air in this blower is parallel to the axis. In other words, the air leaves in the same direction as it enters and in the case of long pipes subject to leakage two or more blowers can be installed between the ends, thus delivering a positive flow of air at low pressure and small resultant leakage. It is claimed for this propeller blower that its efficiency runs up to 80 per cent; that the power consumption at constant speed is practically unaffected by variations in air delivery or pressure and that the blower can operate against pressures up to eight inches of water. On account of these advantages, the blower is adapted to use in providing forced draft, induced draft, main and individual room or tunnel ventilation, air heating and drying installations, cooling of electric motors and generators, ventilation of factories, boiler rooms, etc.



The Coppus Blower Receives and Delivers Air Parallel to the Axis

Overhead Handling System Lowers Shop Costs

IN the efforts towards reducing costs of railway shop operation mechanical devices are taking an important part. In repair shops, machine shops, etc., where floor space is at a premium the overhead methods of handling—cranes, monorails, tramrails, etc.—offer important advantages. For use in such shops the Cleveland Crane & Engineering Company, Wickliffe, Ohio, has developed a tramrail which may also be used with success in freight terminals where the overhead method provides the answer to the handling problem.



The Curves in the Rail Illustrate the Flexibility of the Tramrail System

The feature of this system, which is the flexibility of the installation of the rail, is evidenced by the methods of suspension. These consist of hanger rods, brackets and rail clamps which can be attached to the purlins of a building or almost any support available. For all loads up to the maximum capacity of two tons the rail support clamps are placed three feet apart.

The system is standardized and a mechanic can layout, order and install the rail, rail fittings, switches, turntables, carriers, etc. By the use of cold bends in the rail any curve down to a 4-ft. radius can be made without sacrifice of safety. The bend is easily made by the use of a special bending device.

Like the other units of the system, the switches designed for this tramrail are standard. The same switch is installed for hand power or electric operation, thus permitting a hand power system to be electrified at any time. In this switch, both the stationary and movable rail are held in firm contact, eliminating the open space at the point where the rails join. Safety has been given special attention with the result that the instant a switch is opened a safety stop drops on the rail, preventing the carrier from passing that point. When the switch is in position it is automatically locked, thus preventing the carrier and its load from sliding the switch out of alinement. When additional safety is desired, the installation of trolley wire insulator makes it impossible for an electrically driven carrier to run at full speed against a safety stop or open switch.

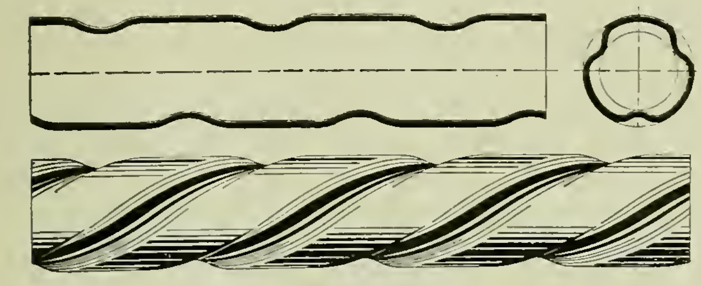
In an installation it is often found necessary to install the rail at different levels. This means that the carriers must negotiate a grade. Up to a grade of 12.5 per cent the electrically driven carrier has ample power to operate with its full load. This makes the employment of a brake essential, which is fully met by a foot brake which is provided only on carriers traveling a grade. Where the difference in levels is greater than it is practical to climb, an ordinary freight elevator is installed with the tramrail. This method safely lifts or lowers the carrier and load to the desired level without rehandling and requires but one man.

By the use of a central control system several carriers can be operated by one man. Where an unobstructed view of the system is not possible, the operator is informed as to the location of the carriers he controls by signal lights on a board before him. With this arrangement the dispatcher can switch the carrier to any track or location desired.

Through combinations 1,200 types of carriers are possible with the standard equipment. An important innovation of this system is the manner of installing the tramrail transfer bridge which gives accessibility to every point on the floor. A standard rail, installed along the length of the building on both sides, forms the runway for the transfer bridge which permits the carriers to operate from the tramrail track onto the bridge. Working parts are fully enclosed so that fumes, moisture and dirt cannot shorten their life. The ball bearings and other bearings of bronze graphite inserted bushings with ample provision for self lubrication are so placed that if it becomes necessary to remove them they are readily accessible.

New Type of Spiral Boiler Tubes Developed in Sweeden

SPIRAL boiler tubes of round section and of a form which might be called a single thread of small pitch have been used to a limited extent in European locomotives for many years. While they have often shown economies during tests, they have frequently failed to maintain such economies after continued service and their use has been discontinued in most places. The reason for their failure to meet expectations is apparently due to a large extent to their form and the small pitch which considerably increase the resistance to the passage of the smoke gases and in addition afford pockets in which the soot lodges, consequently reducing the heating efficiency of the tubes.


"Ess" Spiral Boiler Tube

Comparative Results of Boiler Tube Tests

Locomotive type	0-6-0		0-8-0			4-6-0	
Service	Freight		Freight			Passenger	
Weight on drivers	70,350 lb.		110,250 lb.			81,600 lb.	
Total weight of engines	70,350 lb.		110,250 lb.			125,250 lb.	
Cylinders, diameter and stroke	17 in. by 24 in		21⅝ in. by 25 3/16 in.			20½ in. by 24 in.	
Grate area	15.1 sq. ft.		23.7 sq. ft.			25.8 sq. ft.	
Tubes, number and diameter	186-1⅞ in.		127-1⅞ in.			127-1⅞ in.	
Flues, number and diameter	....		21-5 in.			21-5 in.	
Tubes and flues, length	9 ft. 9 in.		13 ft. 11 in.			13 ft. 11 in.	
Test number	1	2	3	4	5	6	7
Kind of tubes	Plain	Spiral	Plain	Spiral	Spiral	Plain	Spiral
Superheater units	....	....	Straight	Straight	Spiral	Straight	Spiral
Firebox	....	....	Copper	Copper	Steel	Steel	Copper
Length of run	219 miles	219 miles	219 miles	219 miles	219 miles	209 miles	209 miles
Time of run	12 hr 59 min.	13 hr. 14 min.	13 hr. 22 min.	13 hr. 22 min.	13 hr. 22 min.	6 hr. 24 min.	6 hr. 24 min.
Coal burned	10,212 lb.	8,162 lb.	13,944 lb.	11,851 lb.	10,553 lb.	7,687 lb.	7,284 lb.
Draft in smokebox water column	....	....	3¼ in.	2 7/16 in.	2 11/16 in.	3¾ in.	3 9/16 in.
Temperature gas from tubes	630 deg. F.	410 deg. F.	545 deg. F.	406 deg. F.	433 deg. F.	669 deg. F.	520 deg. F.
Temperature gas from flues	....	....	507 deg. F.	475 deg. F.	450 deg. F.	565 deg. F.	500 deg. F.
Boiler water temperature	351 deg. F.	352 deg. F.	358 deg. F.	360 deg. F.	356 deg. F.	374 deg. F.	372 deg. F.
Superheated steam temperature	....	....	504 deg. F.	518 deg. F.	514 deg. F.	536 deg. F.	559 deg. F.
Water evaporated per pound of fuel	6.73 lb.	8.26 lb.	8.4 lb.	9.3 lb.	10.1 lb.	8.06 lb.	9.41 lb.
Increased boiler efficiency, per cent.	....	22.8	....	10.7	20.2	....	16.7
Saving in fuel, per cent	......	18.5	....	9.7	16.8	....	14.4

In an endeavor to overcome these faults, Nordling and Bengtzon of Amal, Sweden, brought out a few years ago a new form of spiral tube known as the "Ess" tube which is manufactured by the Uddeholms Aktiebolag, Uddeholm, Sweden. As will be noted from the illustration, the cross-section is of a circular form broken by three wave-like recesses while the pitch is about eight inches. This form offers less frictional resistance to the gases than the older form of spiral, has 90 per cent of the cross-sectional area of the round tube and a slightly greater heating surface. It imparts to the gases a rapidly whirling motion and experience has shown that it is practically self-cleaning.

It is also claimed that this form of tube is a reliable spark extinguisher, the larger particles being broken up during their passage through the tubes. Several hundred coal-burning locomotives equipped with these tubes are operated in Sweden without other spark arresters, although with low exhaust nozzles a small deflector is attached to the front tube sheet. This practice is possible with the rates of combustion and amount of draft there used even though the same practice could not be followed under the conditions prevailing in American locomotive operation.

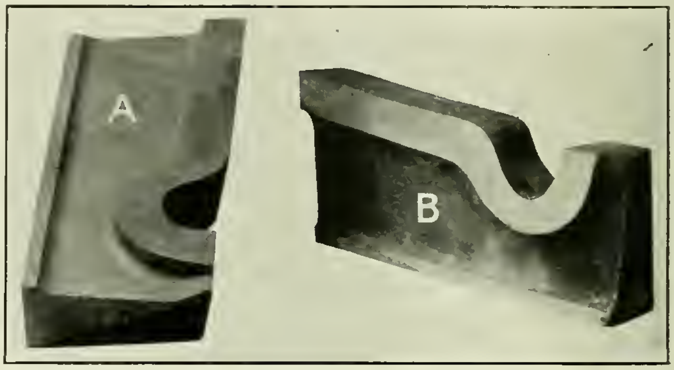
In superheated steam locomotives the flow of gases must be properly divided between the small heating tubes and the large flues containing the superheater elements in order that the desired degree of superheat may be obtained. In locomotives equipped with spiral heating tubes, it has been found advisable to twist the superheater elements into a screw shape, two or three turns ordinarily being sufficient for European conditions. By so doing the flow of gases through the tubes and flues is equalized and a rotating action is also imparted to the gases passing through the superheater flues, thus adding still further to the efficiency of the boiler.

Repeated tests have been made with both saturated steam and with superheated steam locomotives in passenger and freight service. In all cases the locomotives compared differed only in tubes and in form of superheater elements. The results of a few of these tests, shown in tabulated form, indicate the savings obtained.

Drop Forged Cutters for Wheel Lathes

The forming of blanks for various types of milling cutters by the drop forging process possesses a number of advantages over the use of full size bar stock. Principal among these may be mentioned the refinement of structure resulting from the additional working of the material, the attainment of a higher degree of homogeneity in the structure of the material than is possible in large bar sections and the saving in the amount of material removed in the finish.

The drop forging process has been applied with similar advantages to the manufacture of large forming tools for wheel lathes. It has been claimed that high speed steel cannot be forged in this manner but bold indeed is the man who will put his finger on any single operation and say to the American manufacturer, "This cannot be done." High speed cutter blanks for side mills, end mills, hobs and many special tools are being successfully drop forged. The illustration shows a drop forged wheel lathe forming tool blank *A* and the finished tool *B*, from which it is evident that the only work required to finish the blank is a comparatively small amount of grinding. These blanks are made by the Forge Products Corporation, Ann Arbor, Mich.



View of Cutter Before and After Grinding

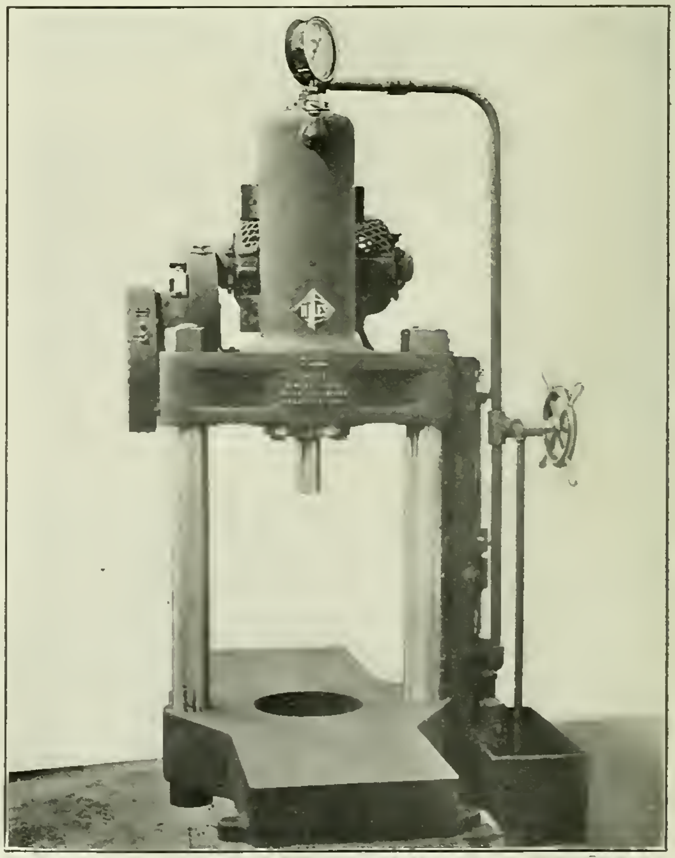
Hydraulic Driving Box and Rod Bushing Press

The hydraulic press illustrated has been developed by the Niles-Bement-Pond Company, New York, as a quick and convenient means of pressing brasses into or out of locomotive driving boxes. It is also particularly adapted to applying and removing rod brasses and other similar work. The base plate for supporting the work is tied to the cylinder by heavy steel tie bolts. The ram moves downward by hydraulic pressure from a power driven pump forming part of the machine.

The base plate is planed on its top surface and has a hole at its center to permit the passage of shafts or bushings which are being pressed out. This hole can be made to conform in shape and size to the requirements of the work. The steel tie bolts are shouldered to maintain the distance between the base plate and the resistance head.

The cylinder is lined with copper expanded into place and burnished. The piston is packed with cup leather, being tight and durable and causing little friction. The driving mechanism is mounted on the cylinder and is geared to a horizontal shaft which drives the pump located at the side of the press convenient to the operator. The pump has one or two plungers in accordance with the power of the press. Safety valves are provided for each pump plunger and can be set to release at predetermined pressures. The design of the pump is such that any plunger can be instantly thrown into or out of operation. A hand wheel operates a release valve which when opened permits the water to flow back into the pump suction tank, provision being made for automatically raising the ram upon the release of the pressure. A gage is provided which indicates the pressure on the ram in pounds per square inch and the total pressure in tons. The drive can be either by belt through tight and loose pulleys or by direct attached constant speed motor for direct or alternating current.

The length of the 50-ton press base plate is 60 in., the width between tie bolts being 22½ in. The stroke of the ram is 13 in. and the maximum allowable height of work 26 in. One pump plunger is used, approximately five horsepower being required to drive the press. The base plate of the 100-ton press is 60 in. in length, the width between tie



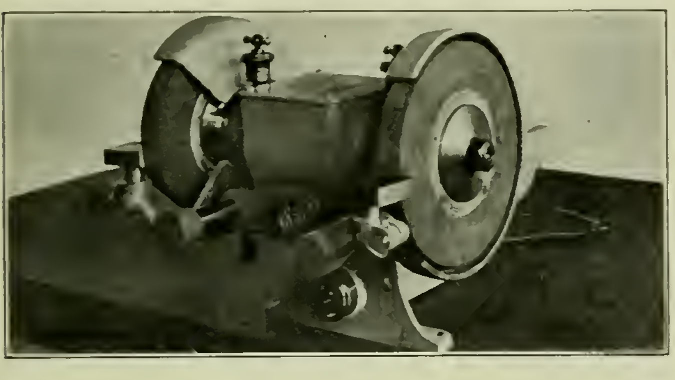
Niles-Bement-Pond 50-Ton Press

bolts being 28½ in. The stroke of the ram, as in the case of the smaller press, is 13 in., but work 36 in. high can be accommodated under the ram. Two pump plungers are used and a 7½-h.p. motor is required to drive the press.

The 100-ton press is regularly equipped with a swiveling crane mounted on an extension of the base plate and supporting a chain hoist of 2,000 lb. capacity. Such a crane can be supplied on the 50-ton press to order only.

Eight-Inch Electric Bench Grinder

THE Black & Decker Mfg. Company, Baltimore, Md., announces a new model grinder known as the Eight-Inch Electric Bench Grinder. This is a substantial two-wheel grinder, driven by a ¾-h.p. motor of the universal type similar to motors used in Black & Decker portable electric drills. It operates on alternating or direct current at will. Among the interesting features of this new model is the arrangement of the grinding wheels, which are set well forward of the motor casing and arranged so that they overhang the bench. This makes it possible to grind long pieces and odd shapes with unusual facility and also makes it possible to wear the grinding wheels down to the clamp washers, thus avoiding wheel wastage.


Black & Decker 8-In. Bench Grinder

The motor is air-cooled and arranged so that the air intake is located 12 in. from the grinding wheels in order to reduce the possibility of grit being drawn into the machine. The machine is grease lubricated throughout.

The grinder is furnished complete with two grinding wheels, one coarse and one fine, 8 in. in diameter and ¾ in. wide; two wheel guards, two adjustable tool rests, an electric cable fitted with attachment plug and switch. A grinder of this type is particularly adapted to use in machine shops, and when installed at convenient locations on the benches will undoubtedly save many steps and a large amount of time formerly spent going to grinders located at a distance.

Recent Improvements in Adjustable Crosshead

EXTENDED use on several classes of large freight and passenger locomotives has demonstrated the value of the adjustable crosshead, made by the Rogatchoff Company, Baltimore, Md., and described on page 1619 of the June 9, 1920, Railway Age. Since the publication of that article, however, the crosshead has been altered in two respects which, while apparently simple, increase the possible adjustment of the crosshead and reduce the cost of one of the machining operations.

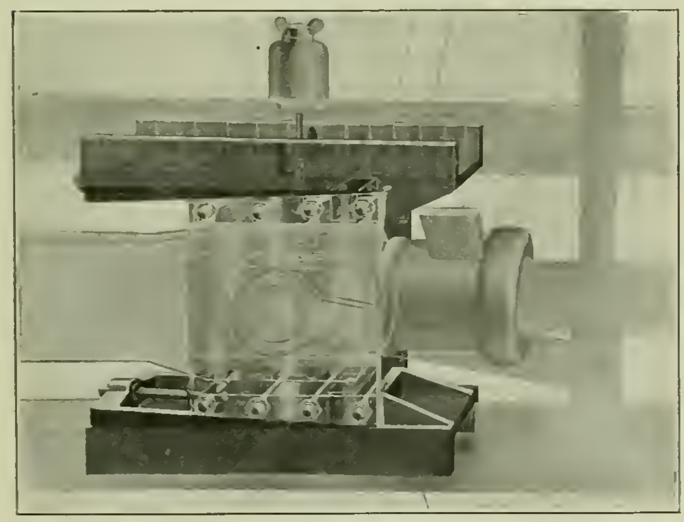


Fig. 1. General View of Rogatchoff Adjustable Crosshead

Reference to the original description of the Rogatchoff crosshead shows that only one adjustable taper wedge was used, this being provided on the bottom shoe. In order to increase the possible range of adjustment and compensate for a greater wear of both guide and crosshead shoe, a second case-hardened wedge has been applied to the upper crosshead shoe as shown in Fig. 1. By these two taper wedges an adjustment of approximately 7/16 in. can be obtained.

Reference to the end view in Fig. 2 shows that the part of the shoe extending between the crosshead sides has been machined with straight parallel sides, whereas the original shoe was provided with taper sides at this point. The elimination of the taper is a considerable advantage from the point of view of reduction in machining cost and greater ease in applying the shoes. It is also in accordance with the usual practice in making crosshead shoes.

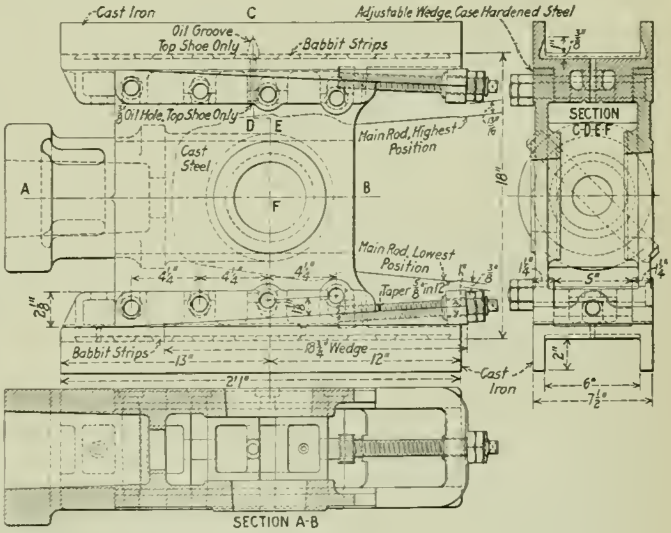


Fig. 2. Drawing Showing Alterations in Adjustable Crosshead

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WE GUARANTEE, that of this issue 7,500 copies were printed; that of these 7,500 copies 6,743 were mailed to regular paid subscribers, 10 were provided for counter and news company sales, 227 were mailed to advertisers, 8 were mailed to employees and correspondents and 512 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 108,100, an average of 9,008 copies a month.

The *Railway Mechanical Engineer* is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.)

Seven hundred men returned to work after a long lay-off when the Chicago Great Western shops at Oelwein, Iowa, were opened on October 16.

A fire at Mobile, Ala., on October 26, destroyed 21 cars in the Mobile & Ohio yard. Estimated loss, $25,000. Sparks from a locomotive are given as the cause.

One hundred and fifty additional men are to be added to the New York Central locomotive shop forces at West Albany, N. Y., this increase in force to take place as fast as competent men can be obtained.

The Norfolk & Western reports the total number of persons killed on that road in 1920 as 84; a figure which marks a remarkable decrease from 1912, when the total was 229; while at the same time there has been a steady increase in the volume of freight traffic.

The Interstate Commerce Commission has issued Accident Bulletin No. 78, containing the record of collisions, derailments and other accidents on the railroads of the United States for the last quarter of 1920, and also for the 12 months ending with December. The number of passengers killed in train accidents in the twelve months was 95, as compared with 110 in the preceding year; and of employes, 430 as compared with 366.

J. E. Fairbanks, general secretary, has sent out a blank for the letter ballot under which members of the American Railway Association are to vote for members of the board of directors; and in connection therewith, by circular No. 2200, the directors recommend, for the better geographical representation of members on the board, that the number of directors be increased from 18 to 21. This involves changes in article 7 of the constitution and sections 3, 5 and 19 of the by-laws.

The Chicago, Rock Island & Pacific has started preparations for the celebration of its seventieth anniversary which occurs on October 10, 1922. Inquiries have recently been sent to the various employes associations and officers of the company asking that suggestions and plans be submitted for a fitting commemoration of the occasion. It has already been suggested that the first Rock Island train, which made its initial run between Chicago and Joliet, Ill., in 1852, be re-constructed.

The Elmira Division of the Pennsylvania Railroad reports that for a period of 56 days, August 13 to October 7, there was not a single minute's detention to a passenger train on the division due to engine failures. For a period of 39 days, August 28 to October 6 inclusive, there were no delays from car failures. In making this record 752 trains were operated a total distance of 69,154 miles. Ninety-seven per cent of the trains maintained schedule time. This division is 143½ miles long, and contains many sharp curves. There are two long and steep grades of two per cent each, in both directions.

John E. Oldham, of the Boston banking firm of Merrill, Oldham & Co., is sponsor for a new plan of railroad consolidation. Mr. Oldham's plan which differs greatly from the plan made public by the Interstate Commerce Commission on September 28, was presented at the convention of the Investment Bankers' Association of America at New Orleans, La., on November 1. It has also been published by that organization in a booklet of 64 pages illustrated with 13 insert maps in colors.

Walker D. Hines, formerly director general of railroads, on his recent return to this country, after having spent over 16 months in Europe, said that railroad transportation conditions had been improved much more in France than in eastern Europe, where there has been much confusion resulting from the delays in allocating the rolling stock that was seized and otherwise scattered during the war. This has led to much trans-shipment at the frontiers and has resulted in stimulating the river traffic.

The Executive Committee of the Railway Supply Manufacturers' Association met at the Waldorf-Astoria Hotel, New York City, October 26, 1921. The situation was thoroughly discussed regarding the meeting and exhibits of the Association for 1922. The letter ballot as to the preference of all members indicated a three-to-one vote in favor of the meeting and exhibits. The letter ballot and reports from the various members of the committee representing all parts of the United States, showed also that the members were decidedly in favor of going to Atlantic City for the meeting and exhibits. A formal vote was taken and it was unanimously decided to hold the 1922 meeting and exhibits in Atlantic City, New Jersey.

German Locomotives for Spain

It is reported that four German-built locomotives, each of a total weight of 96 tons, have been delivered at Port Bon, Catalonia, Spain, for use on the Madrid, Saragossa & Alicante railway. Twenty-one similar engines are on order.

German Rolling Stock Allocated to Danzic Territory

The following German rolling stock has recently been definitely allocated to the Danzig territory by the Interallied Commission sitting in Berlin, according to a report from Consul William Dawson: locomotives, 116; passenger cars, 172; baggage cars, 35; freight cars, 1,950; and electric locomotives, 2.

Russian Shipyard to Repair Locomotives

It is reported that the Balto-British Shipyard Company, Reval, Russia has undertaken the repair of one thousand locomotives for the Russian railways during the next five years.

Increase in Value of Exports of Electric Locomotives

During the first nine months of 1920, electric locomotives valued at $844,130 were exported from this country, according to Commerce Reports. In 1921 for the same period the value of electric locomotives exported was $1,506,877.

South Manchuria to Buy Supplies Here

The South Manchuria Railway plans to spend approximately $20,000,000 annually in the United States, during the next few years for railway equipment and supplies, according to the New York Evening Post, which ascribes the statement to Yozo Tamura, an officer of the company, who recently arrived from Japan.

Bangor & Aroostook Leases Car Shops

The car shops of the Bangor & Aroostook at Houlton, Me., which normally employs between 30 and 40 men, has been leased to A. E. Astle, Houlton, Me., who will make repairs to cars on a contract basis. This action was taken because output had been unsatisfactory and the size of the shops did not warrant additional expense for supervision. The railroad estimates that the new arrangement will effect a saving to the company in labor costs of approximately 10 per cent.

Addition to M. D. T. Company's Shop

The Merchants' Dispatch Transportation Company is making extensive additions to its car shop at East Rochester, N. Y Approximately 125,000 square feet of space is being provided for repairs to steel cars. The shop is to be of steel frame construction with steel sash and will be fitted with modern equipment for repairing or rebuilding steel freight cars. In addition a new blacksmith shop of 10,000 square feet floor area has recently been erected.

Annual Meeting American Railway Association

The annual meeting of the American Railway Association was held at the Waldorf-Astoria Hotel, New York, on Wednesday, November 16, with an attendance of about 200 and R. H. Aishton, president of the association, in the chair. The membership now includes 391 full members and 345 associate members, operating 314,019 miles of road. The board of directors reported that since the last meeting, a Safety Section had been created within the Operating Division; and that M. J. Gormley has been appointed chairman of the Car Service Division at Washington.

N. Y. C. Leases Shops

The New York Central has leased its car repair shops at East Buffalo, N. Y., to William J. Conners, a prominent business man of that city, and work was resumed this week after an almost complete suspension for about eight months. The lessee expects to employ from 1,500 to 2,000 men. The manager of the shops, under Mr. Conners, will be James J. Barrett. It is proposed to make the work-day ten hours.

It is understood that negotiations are pending for a similar disposal of the extensive shops at West Albany, N. Y.

It is reported that the shops at Collinwood, Ohio (Cleveland), and those at Air Line Junction, near Toledo, have been leased to the A. S. Hecker Company, of Cleveland.

Obsequies for Steam Locomotive Will Not Be Staged for Some Time

The Superpower Survey report was discussed by W. J. Cunningham, professor of transportation, Harvard University, in an article which appeared in the New York Evening Post, November 15. In commenting on the position of the steam locomotive, he said:

"From time to time, as certain railroads have changed from steam to electrical operation for portions of their lines, the passing of the steam locomotive has been confidently predicted by experts who have been impressed with the superiority of electric traction, but the steam locomotive not only appears to be holding its own, but by notable improvements in design and appurtenances seems recently to have taken a new lease of life."

The Freight Car Situation

The Car Service Division of the American Railway Association reported a total of 354,996 bad order freight cars on October 15, or 15.5 per cent as compared with 15.8 per cent on October 1. On November 1 this total showed another slight decrease, the total being 345,201 cars, or 15 per cent.

Surplus Serviceable Cars

The freight car surplus continued to decrease during the weeks ended October 15, October 23 and November 1. During these periods the totals reported by the Car Service Division of the American Railway Association were 121,944, 99,971 and 80,203 cars respectively.

Ben W. Hooper to Be Guest of the New York Railroad Club

Ben W. Hooper, a member of the public group of the Railroad Labor Board and former Governor of Tennessee, is to be the speaker and guest of honor at the third annual dinner of the New York Railroad Club, which will be held at the Commodore Hotel, New York, Friday evening, December 15. Mr. Hooper played a most important part in the recent wage controversy. Tickets for the dinner may be had by applying to W. J. Moody, treasurer, Erie Railroad, 50 Church street, New York City.

Car Loadings

The Car Service Division of the American Railway Association reported an increase of 10,294 cars during the week ended October 15 when the number of cars loaded with revenue freight totaled 906,034.

Another increase was noted in the total for the week ended October 22. During this period 962,292 cars were loaded, or 56,258 cars more than reported for the previous week.

For the week ended October 29, however, the cars loaded totaled 952,261, a decrease of 10,031 cars as compared with the total for the preceding week which was abnormal because of the strike threat.

During the week ended November 5, loading of revenue freight totaled 829,722 cars. This was a reduction of 122,899 cars when compared with the total for the previous week, 85,893 cars less when compared with the total for the corresponding week of 1920, and 2,998 cars more than were loaded during the corresponding week of 1919.

Germany Considering Denationalization of Railways

Brig.-General Sir Henry W. Thornton, general manager of the Great Eastern Railway, England, has recently returned from a trip to Germany and brings the information that whereas the Germans found it possible to operate the railways economically as a nationalized system under the monarchy, it has been found impossible under the present form of government to approach anywhere near the satisfactory results previously obtained. Serious consideration is therefore being given to turning the railways over to private interests for operation. Various press dispatches have indicated the likelihood of Hugo Stinnes, Germany's great industrial magnate, taking over the entire railway system.

Canadian Tank Cars for Soviet Russia

Five hundred tank cars built in Canada will immediately be placed on Canadian steamers for transportation to Novorossiisk, a Russian port on the Black Sea, according to a report from Consul Felix S. S. Johnson, at Kingston, Ontario. Four of the largest Canadian government freighters will be employed to carry the cars to Russia, and it is expected that final shipment will be made before the close of navigation.

The contract for the manufacture of the tank cars was secured through the Soviet Trade Commission, London, at a price of $2,000,000. The cars, which are being built to the Russian gage of five feet, will be used in Russia's extensive oil fields. A technical expert representing the Soviet government is now in Canada testing the completed cars, and as these are approved they are placed on board the two government ships which will carry the first shipment to Russia. The remainder of the cars will follow aboard two other government vessels before the close of navigation.

Locomotive Orders

THE SOUTHERN PACIFIC has ordered 50 Santa Fe type locomotives from the Baldwin Locomotive Works.

Freight Car Orders

THE CENTRAL OF NEW JERSEY has ordered 125 50-ton coal cars and 85, 40-ton box cars from the Standard Steel Car Company.

THE ALABAMA, TENNESSEE & NORTHERN has given an order to the Mt. Vernon Car Manufacturing Company for 300 standard freight cars.

THE DENVER & RIO GRANDE has ordered 700 70-ton gondola cars, with an option of 300 additional, from the Pressed Steel Car Company.

THE PENNSYLVANIA TANK LINE, Sharon, Pa., has ordered 200 tank cars of 10,000 gal. capacity from the Pennsylvania Tank Car Company.

THE CHICAGO, MILWAUKEE & ST. PAUL has ordered 1,000 gondola cars of 50-ton capacity from the Bettendorf Company and 1,500 from the Haskell & Barker Car Company.

THE ATCHISON, TOPEKA & SANTA FE has awarded a contract for 1,250 refrigerator cars to the American Car & Foundry Company and 1,250 of the same type to the Haskell & Barker Car Company.

THE ILLINOIS CENTRAL has awarded a contract for 350 40-ton refrigerator cars to the General American Car Company, and for 650 of the same type to the Haskell & Barker Car Company. Delivery is to be started by February 1, 1922, and is to be completed not later than March 10, 1922.

THE CHICAGO, BURLINGTON & QUINCY, on November 7, authorized the expenditure of $15,000,000 for the purchase of 7,000 freight cars, 55 heavy freight and passenger locomotives and 127 all-steel passenger cars, to be used on the three lines operated by the company.

Contracts for Car Repairs

THE WABASH has given a contract to the Western Steel Car & Foundry Company for the repair of 250 hopper cars.

THE ERIE will have repairs made to 100 50-ton steel coal cars at the shops of the Pennsylvania Tank Car Company.

THE CHICAGO & ALTON has awarded a contract for the repair of 200 gondola cars to the Mount Vernon Car Company, Mt. Vernon, Ill.

THE ATCHISON, TOPEKA & SANTA FE has awarded a contract for the conversion of 50 box cars into cabooses to the American Car & Foundry Company.

THE CHICAGO, BURLINGTON & QUINCY has given a contract to the Western Steel Car & Foundry Company for repair work on 300 of its gondola cars.

THE CANADIAN NATIONAL RAILWAYS have let contracts to the Canadian Car & Foundry Company and the Eastern Car Company for the repair of 3,000 box cars with wood underframes.

THE TOLEDO & OHIO CENTRAL has entered into a contract with the Ralston Steel Car Company for the repair of about 360 cars, for this road and the Kanawha & Michigan. A contract has also been given by the Toledo & Ohio Central to the Hamilton Car Company, Newark, Ohio, for the repair of 200 box cars.

Shop Construction

SEWELL VALLEY.—This company has placed an order for the erection of a shop building at Rainelle, W. Va., with the Truscon Steel Company, Youngstown, Ohio.

ST. LOUIS-SAN FRANCISCO.—This company has awarded a contract for the construction of a one-story machine shop, 103 ft. by 40 ft., at St. Louis, Mo., to the Globe Construction Company, St. Louis, Mo.

MISSOURI PACIFIC.—This company has awarded a contract for the construction of two brick car repair sheds, 46 ft. by 500 ft. at St. Louis, Mo., to Joseph E. Nelson & Sons, Chicago.

CHICAGO, BURLINGTON & QUINCY.—This company has awarded a contract to the Materne Manufacturing Company, St. Louis, for the installation of a heating and washout system in its new engine house at Centralia, Ills.

MISSOURI, KANSAS & TEXAS.—This company has awarded a contract to T. L. Johnson, Sedalia, Mo., for the reconstruction of its reclamation plant at Parson, Kan., which was destroyed by fire on September 17, at an estimated loss of $85,000.

American Society for Steel Treating Meeting

At the meeting of the board of directors of the American Society for Steel Treating, held at Cleveland, Ohio, during the week of November 7, it was decided to hold two sectional meetings of the society during the coming year, one in New York during January or February, and the other in Pittsburgh, Pa., in May. These meetings, at which one or two well chosen, preprinted papers will be presented, will be of one or two days' duration and will be in addition to the annual convention and exposition which will be held at Detroit, Mich., September 25 to 30, 1922.

New Motive Power for the Railways of Mexico

The Baldwin Locomotive Works has recently completed a group of locomotives of various types for the railways of Mexico, which are of interest not only from an engineering standpoint but also because their construction represents an important item in the plans now being carried out for the rehabilitation of these lines. The locomotives referred to include 83 for the National Railways of Mexico and 11 for the Mexican Railway, besides a number of others built for industrial companies.

The locomotives for the National Railways are of three types: 20 Pacific (4-6-2) for passenger service, 23 Mikados (2-8-2) for heavy freight service and 40 Consolidations (2-8-0) for lighter freight service. These locomotives all use a heavy grade of Mexican oil for fuel, and are of standard gage with the exception of 20 of the Consolidations, which are 3 ft. gage.

Anthracite Shipments—October, 1921

The shipments of anthracite for October, as reported to the Anthracite Bureau of Information, Philadelphia, amount to 5,872,753 tons against 5,519,412 for the preceding month of September, an increase of 353,371 tons, but show a decrease over October of last year of 368,118 tons, when 6,240,901 tons were recorded. October of this year can be considered a fair average shipment when consideration is given to the fact that a number of mines in the Scranton district were idle during the month owing to the fact that they could not operate under the provisions of the Kohler Act. Operations at these mines were resumed, however, on November 2. The total shipments for the coal year beginning April 1 have amounted to 40,223,367 tons but as compared with 39,720,654 tons for the corresponding period last year, a gain of 502,713 tons.

Central Europe's Roads Need Fuel and Equipment

The railway lines of what was formerly the Austro-Hungarian empire are all intact and are in the main in excellent physical condition, but normal traffic will never be resumed until the new states which were formed out of the former Austro-Hungarian empire are willing to co-ordinate their resources and facilities. Naturally there is a shortage of rolling stock, both motive power and cars, but, for the present, it would not be necessary to build a single new locomotive or a single new car if the bad order locomotives and cars which have been standing around for three years were repaired and put in service. It is not necessary to state that these bad order locomotives and cars could be available for service at a fraction of the cost of purchasing new equipment.

In 1919 and the first half of 1920 shortage of coal was a bad handicap to railroad operation in all the succession states. During the past six months there has been a considerable increase in coal production, or at least in the allocation of coal for transportation purposes, and now the principal trouble is shortage of locomotives and cars.

Polish Government Places Order for Locomotives and Cars

The Polish ministry of railways has placed orders with Polish firms for 2,970 locomotives, 7,800 passenger coaches, and 70,000 freight cars, according to a report published in the Warsaw Polish Courier and transmitted to Commerce Reports by Consul General L. J. Keena of Warsaw.

The orders were distributed as follows: First Locomotive Construction Company, Chrzanow, 1,200 locomotives; Locomotive Construction Company, Warsaw, 360 locomotives; H. Cegielski Company, Posen, 1,410 locomotives and 4,400 coaches and freight cars; Wagon Car Factory, Ostrow, 2,800 coaches and 18,000 freight cars; Lipop, Rau and Loewenstein, Warsaw, 3,000 coaches and 20,000 freight cars; Boiler Manufacturing Company Ostrowiec, 20,000 freight cars.

The contracts for locomotives run to 1932, and the contracts for passenger coaches and freight cars to 1922. Nearly 200 locomotives are to be delivered during the first two years.

C. S. Gaskill Joins Russian Mission of American Relief Administration

Charles S. Gaskill, formerly master mechanic of the Pennsylvania at Baltimore, sailed on October 4 to join the staff of Colonel W. N. Haskell, director of the American Relief Administration's Mission to Russia. Mr. Gaskill will have charge of the transportation of the foodstuffs with which the Administration proposes to supply the Russians. Mr. Gaskill was born at Mount Holly, N. J., on October 11, 1877. He was graduated from Princeton in 1898 and entered the employ of the mechanical department of the Pennsylvania at its Altoona shops. In 1917 he left his position as master mechanic at Baltimore to join the Railway engineers of the A. E. F. He was commissioned major and, later, lieutenant colonel. Following his discharge from the army, Mr. Gaskill became technical adviser to the Polish Ministry of Railways and held that position until quite recently when, having returned to this country to take up railway work again, he received his appointment to serve under Colonel Haskell.

C. S. Gaskill

Annual Dinner of Central Railway Club

The Central Railway Club held its annual dinner at the Hotel Iroquois, Buffalo, N. Y., on the evening of November 10. About 300 railroad men and guests attended, a large number coming from other cities, including a delegation in two special cars from New York. W. H. Flynn, superintendent of motive power of the Michigan Central and president of the club, introduced Hon. Charles F. Moore, who acted as toastmaster. At the conclusion of the dinner Arthur T. Baldwin, vice-president of the McGraw-Hill Company, delivered an address.

Frank C. Pickard, a former president of the club, was presented with a testimonial in recognition of his work for the organization, the presentation being made by W. F. Jones, also a past president.

Announcement was made of the election of the following officers to serve for next year: President, George Thibaut, master mechanic, Erie railroad; first vice-president, W. O. Thompson, general superintendent rolling stock, New York Central; second vice-president, J. R. Schrader, general car foreman, New York Central; third vice-president, C. L. McIlvaine, superintendent motive power, Pennsylvania, Central region. Members of executive committee: A. N. Dugan, Bronze Metal Company; J. M. Gaiser, Erie, and T. J. O'Donnell, chief joint inspector, Buffalo.

Rumored Pullman and Haskell & Barker Will Combine

The final details of the rumored merging of the Pullman Company and the Haskell & Barker Car Company, it is reported, were agreed on by committees representing both companies at Chicago on November 14. These committees are expected to report to their respective directorates within a short time, and it is expected that the directors will then call for a special meeting to vote approval of the plan, which provides for the giving of 3 shares of the stock of the Pullman Company in exchange for 4 shares of Haskell & Barker.

It is also reported that John S. Runnels, president of the Pullman Company, is to become chairman of the board of directors of the new company and Edward F. Carry, president of Haskell & Barker, is to become president. The merger would bring together the Pullman Company, with a capitalization of $173,000,000, and with plants at Pullman, Ill.; St. Louis, Mo.; Wilmington, Del.; Buffalo, N. Y., and Richmond Cal., and, with a capitalizataion of $36,000,000, the Haskell & Barker Car Company, with a plant at Michigan City, Ind., with an annual capacity of 22,500 freight cars.

MEETINGS AND CONVENTIONS

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Next annual convention June 14 to 21, 1922, Atlantic City, N. J.

Division V—Equipment Painting Division.—V. R. Hawthorne, Chicago.

American Railway Association, Division VI.—Purchases and Stores.—J. P. Murphy, N. Y. C., Collinwood, Ohio.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamlin Ave., Chicago.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting Atlantic City, June, 1922.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Annual meeting December 5 to 9.

American Society for Steel Treating.—W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention and exposition September 25 to 30, 1922, Detroit, Mich.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

Canadian Railway Club.—W. A. Booth, 53 Rushbrook St., Montreal, Que. Regular meeting second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Meeting second Monday in month, except June, July and August, New Morrison Hotel, Chicago, Ill.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month except June, July and August, at the American Hotel Annex, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Meeting second Thursday in January, March, May, August and November, Hotel Iroquois, Buffalo, N. Y.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Meeting second Tuesday, February, May, September and November.

Dixie Air Brake Club.—E. F. O'Connor, 10 West Grace St., Richmond, Va.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill. Next annual meeting May, 1922, Chicago.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn.

Master Boilermaker Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y. Next annual convention Hotel Sherman, Chicago, May 23 to 26, 1922.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting December 13. Paper on Rebuilding Old Locomotives will be presented by C. B. Smith, mechanical engineer, Boston & Maine.

New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Third annual dinner December 15.

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Meeting second Thursday of each month in San Francisco and Oakland, Cal., alternately.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meetings fourth Thursday in each month, except June, July and August, at Fort Pitt Hotel, Pittsburgh, Pa.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo. Meeting second Friday of each month, except June, July and August.

Traveling Engineers' Association.—W. O. Thompson, Marine Trust building, Buffalo, N. Y.

Western Railway Club.—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Regular meetings third Monday in each month, except June, July and August.

PERSONAL MENTION

GENERAL

O. S. Jackson has been appointed assistant superintendent of motive power of the Union Pacific, with headquarters at Omaha, Neb.

M. B. McPartland has been appointed superintendent of motive power of the Western Pacific with headquarters at Sacramento, California, and the position of general master mechanic has been abolished.

E. E. Machovec, master mechanic of the Atchison, Topeka & Santa Fe, with headquarters at Argentine, Kan., has been promoted to acting mechanical superintendent of the Northern Lines, Western District, with headquarters at La Junta, Colo., succeeding J. R. Sexton, who has been granted an indefinite leave of absence due to ill health.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

J. E. Carr has been appointed assistant general road foreman of engines of the United Railways of Havana, with headquarters at Cruces, Cuba.

M. C. M. Hatch has been appointed mechanical engineer of the Missouri, Kansas & Texas, with headquarters at Parsons, Kan., succeeding W. H. Maddocks, retired. Mr. Hatch was born at Chelsea, Mass., on March 14, 1882. After two years' attendance at the Massachusetts Institute of Technology, and two years at the University of California, he entered railroad service in June, 1903, working in the Southern Pacific shops at West Oakland, Cal., and in the testing and signal departments for about 18 months and about six months in the Atchison, Topeka & Santa Fe shops at Needles, Cal., and San Bernardino. In June, 1905, he became a draftsman in the motive power department of the Boston & Maine, and in December, 1906, he was promoted to chief draftsman of that road, which position he held until November, 1911, when he was appointed engineer of tests of the New England Lines. In June, 1912, he was appointed superintendent of locomotive fuel service of the Delaware, Lackawanna & Western, which position he resigned in February, 1917, to become assistant to the president of the Locomotive Pulverized Fuel Company. He held this position until January, 1920, when he left this company to become a representative of the Railway & Industrial Engineers. He reentered railroad service in April, 1921, as assistant mechanical engineer of the Missouri, Kansas & Texas, with headquarters at Parsons, Kan., which position he was holding at the time of his recent promotion.

M. C. M. Hatch

J. W. Keppel, general foreman of the Canadian Pacific, with headquarters at Vancouver, B. C., has been promoted to master mechanic of the Regina division, Saskatchewan district, with headquarters at Regina, Sask., succeeding W. G. McPherson.

F. M. Mozley, roundhouse foreman of the Gulf, Colorado & Santa Fe at Gainesville, Tex., has been appointed master mechanic of the Southern division with headquarters at Temple, Tex.

SHOP AND ENGINEHOUSE

J. Gibson, master mechanic of the Canadian Pacific, with headquarters at Moose Jaw, Sask., has been appointed general foreman, with headquarters at Revelstock, B. C. W. G. McPherson, master mechanic, with headquarters at Regina, Sask., succeeds Mr. Gibson at Moose Jaw.

J. McKenzie has been appointed shop superintendent of the Pere Marquette at Ionia, Mich., succeeding J. Speckin, assigned to other duties. W. F. Crowder has succeeded Mr. McKenzie as general car inspector.

A. H. Powell has been appointed superintendent of the Jeffery shops of the Western Pacific, with headquarters at Sacramento, California.

PURCHASING AND STORES

C. W. Dearworth has been appointed division storekeeper of the Erie with headquarters at Huntington, Ind., and R. H. Pauling has been appointed to a similar position with headquarters at Marion, Ohio.

B. T. Jellison, general purchasing agent of the Chesapeake & Ohio, has been appointed special agent, handling special matters assigned, and the position of general purchasing agent has been abolished.

A. Ross has been appointed division storekeeper of the Erie with headquarters at Jersey City, N. J., and M. H. Keyes has been appointed to a similar position with headquarters at Buffalo, N. Y.

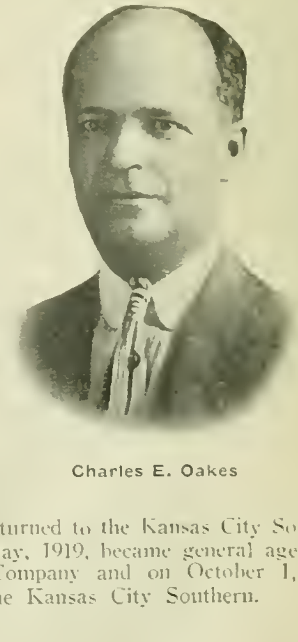
J. M. Velasco, assistant general purchasing agent of the National Railways of Mexico, with headquarters at New York, has been appointed purchasing agent with headquarters at Mexico City. W. L. Wibel succeeds Mr. Velaseo at New York.

OBITUARY

Axel S. Vogt, formerly mechanical engineer of the Pennsylvania, died on November 11 of heart failure.

James D. Collinson, formerly general master mechanic of the Atchison, Topeka & Santa Fe, died at his home in Houston, Tex., on November 9. Mr. Collinson was born in Manchester, England, on January 21, 1849. He first entered railroad service in the mechanical department of the Chicago, Milwaukee & St. Paul. In 1889 he left to become general foreman of the shops of the Atchison, Topeka & Santa Fe at Topeka, Kan., and was thereafter promoted to master mechanic at Raton, N. M., being later transferred to Fort Madison, Iowa. He became superintendent of motive power of the Gulf, Colorado & Santa Fe in 1890, assistant superintendent of motive power of the main line, with headquarters at Topeka, in 1900, and general master mechanic in 1901, during which year he retired from railroad service.

Charles E. Oakes, superintendent of shops of the Kansas City Southern at Pittsburgh, Kans., died on October 13. Mr. Oakes was born January 4, 1880, at Danville, Ill., and entered railroad work at the age of sixteen, his first position being with the Chicago & Eastern Illinois at Danville where he served an apprenticeship to the boilermaker's trade. He was then transferred to the drafting room where he worked his way up to assistant chief draftsman. In October, 1910, he resigned this position to become chief draftsman for the Kansas City Southern with headquarters at Pittsburgh, Kans. This position he held for 11 months, resigning to become chief draftsman of the Missouri Pacific at St. Louis, Mo. On April 16, 1914, he returned to the Kansas City Southern as mechanical engineer; in May, 1919, became general agent for the Peoria Life Insurance Company and on October 1, 1920, superintendent of shops of the Kansas City Southern.



Charles E. Oakes

SUPPLY TRADE NOTES

W. F. Abel has been appointed assistant general manager of sales of the Electric Alloy Steel Company, Youngstown, Ohio.

Walter E. Heibel has accepted a position as sales engineer of the B. F. Sturtevant Company, Boston, Mass., with headquarters in New York.

Walter C. Carroll, assistant general sales manager of the American Sheet & Tin Plate Company at Pittsburgh, Pa., has been appointed vice-president of the Inland Steel Company, Chicago.

Ben L. Whitney, formerly with the Byers Company, has opened an office at 528 Detroit Savings Bank building, Detroit, Mich., and will represent the Orten & Steinbrenner Company in that territory.

Press G. Kennett

Press G Kennett, formerly representative of the Flint Varnish & Color Works, with headquarters at St. Louis, Mo., in charge of sales in the south and southwest, has been appointed manager of the railway sales of the Chicago Varnish Works, with headquarters at Chicago. Mr. Kennett has been with the Flint Varnish & Color Works for the past 12 years, and when the Du Pont interests took over the company he was appointed representative at St. Louis. Prior to going with the Flint concern, he was connected with the purchasing and supply departments of several railroads in the south and southwest, serving as general storekeeper for the Illinois Southern in 1905 and in the same capacity for the Southern Indiana in 1906 and 1907.

W. H. Snedeker, formerly in the Tacoma, Wash., office of the Griffin Wheel Company, Chicago, has been appointed manager of sales at the office established by the company in the Rialto building, San Francisco, Cal.

G. H. Jones, vice-president and one of the founders of the Inland Steel Company, Chicago, will retire from active service in the company about Jan. 1, 1922. Mr. Jones will retain his interest in the company and will continue as a director and a member of the executive committee.

The United States Cast Iron Pipe & Foundry Company, Burlington, N. J., has opened a new office at 811 Dixie Terminal building, Cincinnati, Ohio. P. T. Laws, assistant works manager, now has his headquarters at the new office and Harold G. Henderson is in charge of sales from this office.

C. H. Hobbs, has been appointed assistant general manager of sales of the Detroit Seamless Steel Tube Company of Detroit, Michigan. Mr. Hobbs was in the service of the Lackawanna Steel Company for over 14 years and for the last five years was district representative in charge of its Detroit office.

The H. K. Ferguson Company, Cleveland, Ohio, has arranged with the Morgan Engineering Company, Alliance, Ohio, to design and build gap cranes for locomotive lift-over service. In return the Morgan Engineering Company has made the H. K. Ferguson Company its sales representative in the railway field.

The Virginia Car Corporation, Alexandria, Va., has been organized in Virginia with a capital of $100,000. The officers are E. A. Morse, president, Washington, D. C.; L. D. Christie, treasurer, Alexandria, Va.; S. A. Aplin, secretary, Washington The company will build and repair railroad cars and will lease part of the Virginia Shipbuilding Corporation's plant at Alexandria.

Frank P. Smith for over 20 years identified with the Hancock Inspirator Company, sales department of Manning, Maxwell & Moore, Inc., New York, died on November 3, at his home at Manhattan Beach, N. Y., at the age of 66 years. Mr Smith was in railroad service previous to entering the railway supply field.

M. E. Gregg has been appointed district sales manager for the Lackawanna Steel Company at Detroit, Mich., succeeding C. H. Hobbs. Mr. Gregg has been connected with the general sales department of the Lackawanna for the past two years, prior to which time he was Buffalo district manager for the Republic Iron & Steel Company.

William Bosworth has resigned his position as assistant engineer in charge of contracts and production with the Underfeed Stoker Company of America, Detroit, Mich., to accept the position of mechanical engineer with the Wine Railway Appliance Company, Toledo, Ohio. Mr. Bosworth's experience has been almost entirely railway mechanical engineering. He had been mechanical engineer on several steam railroads prior to three and a half years ago when he became associated with the Underfeed Stoker Company.

The Reilly-Peabody Fuel Company, Pittsburgh, Pa., announces a change in name to Peabody Fuel Company with the following officers: F. E. Peabody, president; R. E. Peabody, vice-president; W. Russell Carr, vice-president; C. M. Rhoads, secretary and treasurer, and T. J. Atchison, general sales manager. All these also are officers of the American Coke Corporation, with the same titles. F. E. Peabody has resigned as treasurer of the Eastern Fuel Company and severed all his connection with that company and its subsidiary, the Georges Creek Coal Mining Company.

James B. Rider

James Brown Rider, vice-president and general manager of the Pressed Steel Car Company and the Western Steel Car & Foundry Company, with headquarters at Pittsburgh, Pa., died on November 2, at Pittsburgh, Pa., after an illness of four months. Mr. Rider was born at Morrison's Cove, Blair County, Pa., on September 10, 1879. He entered the service of the Pennsylvania Railroad in 1895, and remained with it until 1899, acting successively as messenger boy, shop order clerk, invoice clerk and stenographer. In 1899 he became connected with the Pressed Steel Car Company as stenographer and clerk to the general manager, being advanced to the position of assistant to the vice-president in July, 1905. He was appointed general manager in July, 1909, and made a member of the board of directors in January, 1913. Mr. Rider was appointed general manager of the Western Steel Car & Foundry Company in August, 1913, and in December, 1915, he was elected a vice-president of the Pressed Steel Car Company and Western Steel Car & Foundry Company, with headquarters at Pittsburgh; he continued to perform the duties of general manager in charge of operations. He was also vice-president of the American Steel Company of Cuba.

F. L. Kellogg, manager of the New York branch at 25 West Forty-third street, New York City, of the Electric Storage Battery Co., Philadelphia, Pa., has been appointed district manager of the North Atlantic district, with headquarters at 25 West Forty-third street, New York. F. F. Sampson, manager of the Exide depots and garages, succeeds Mr. Kellogg as manager of the New York branch, with D. P. Orcutt as assistant manager. The entire sales organization in New York City was recently consolidated and Mr. Sampson was appointed manager and Mr. Orcutt assistant manager.

Henry P. Hoffstot has been elected vice-president of the Pressed Steel Car Company in addition to his duties as president of the Koppel Industrial Car & Equipment Company. He was formerly manager of sales, central district, of the Pressed Steel Car Company before assuming duties as president of the Koppel Company. C. W. Wrenshall, general superintendent and acting general manager, has been appointed general manager of the Pressed Steel Car Company, and W. A. Chamberlain, formerly auditor, has been appointed comptroller, all with headquarters at Pittsburgh, Pa. C. E. Church, secretary and assistant treasurer, has been appointed secretary and treasurer with office at New York.

The J. G. Brill Company, Philadelphia, Pa., announces the formation of a new company, the Canadian Brill Company, Ltd., organized to build and sell electric and steam railway rolling stock in the Dominion of Canada. The new company has taken over the plant and equipment of the Preston Car & Coach Company, Ltd., Preston, Ontario, and has a number of orders now in process of construction. This plant is a modern car shop, having 11½ acres of ground located on the outskirts of the city. The executives of the new company are: Samuel M. Curwen, president; H. K. Hauck, first vice-president; Alfred Clare, second vice-president; H. D. Scully, general manager and secretary, and E. P. Rawle, treasurer.

Robert A. Ogle, president of the Ogle Construction Company, died on November 2. Mr. Ogle was born at Spalding Springs, Mo., on November 16, 1865. He was engaged in general building contracting at Monroe City, Mo., until 1898, when he organized and became director of the Safety Fund Life Association, subsequently the Missouri State Life Insurance Company. In 1903 he became affiliated with an engineering and construction company at St. Louis, Mo., specializing in the railroad construction field. He left that company in 1906 to enter the service of the Otto Gas Engine Works with headquarters in Chicago. While with this company he was mostly engaged in water service and coaling station construction. In 1911 he organized the Ogle Construction Company at Chicago, and since that time he has been actively identified with the development of coaling station construction and equipment.

Robert A. Ogle

W. H. Rastall has been appointed chief of the Industrial Machinery Division of the Bureau of Foreign and Domestic Commerce and in this position will have charge of the government's activities in furthering American foreign trade in railway equipment and supplies. Mr. Rastall was born in 1879. He was educated in the public schools of Chicago, the Hebron Academy (Maine), the University of Maine and Cornell University, from which institution he was graduated in 1904. Before completing his education, Mr. Rastall served as a draftsman for the Latrobe Steel & Coupler Company, Melrose Park, Ill., and for several shipbuilding companies. From 1904 to 1911 he was resident engineer of the American Trading Company at Kobe, Japan. From 1913 to 1917 he was sales engineer for the Worthington Pump & Machinery Corporation. In the latter year he entered the service of the Bureau of Aircraft Production as an aeronautical mechanical engineer. In October, 1918, he left this position to investigate the markets for American industrial machinery in the Far East in behalf of the Department of Commerce. He was occupied on this mission, until the summer of this year, when he returned to this country to take up his new duties.

TRADE PUBLICATIONS

Drill Chucks.—A series of circulars featuring several types of drill chucks has recently been issued by E. Horton & Son Company, Windsor Locks, Conn.

Belt and Motor-Driven Hammers.—Beaudry & Co., Boston, Mass., has recently issued a 12-page booklet describing and illustrating its Champion type power hammers.

Stokers.—A four-page, colored folder illustrating and outlining the advantages of the Jones automatic cleaning stoker has recently been issued by the Under-Feed Stoker Company, Detroit, Mich.

Chucks.—The Skinner Chuck Company, New Britain, Conn., has recently issued Catalogue No. 35, which is a useful, illustrated source of information on its line of lathe, drill and planer chucks and vises.

High Speed Metal Saws.—The Peerless Machine Company, Racine, Wis., has recently issued a circular containing a complete revision of list prices of its line of high speed metal saws. These prices mark a return to the 1918 basis.

Fuel Oil Engines.—The Hatfield-Penfield Steel Company, Bucyrus, Ohio, has issued two catalogues describing and illustrating its Diesel type vertical and horizontal standard fuel oil engines which are built in two and three cylinder sizes, respectively.

Hydraulic Power Transmissons.—The Oilgear Company, Milwaukee, Wis., has issued a booklet composed of several bulletins which describe and illustrate the variable speed oil-pressure power transmission machinery recently exhibited at Chicago.

Cranes.—Catalogue No. 158, superseding No. 151, has recently been issued by the Whiting Corporation, Harvey, Ill., describing and illustrating its standard crane designs. Several tables of standard clearances and a brief outline of the company's facilities for building cranes are also included.

Valves.—The Pratt & Cady Company, Hartford, Conn., has recently issued Catalogue No. 6 listing its complete line of brass and iron body valves and asbestos packed cocks. This catalogue, which supersedes all previous issues, is a book of 161 pages and contains illustrations, drilling tables, drilling list prices, etc.

Vacuum Pumps.—Several new features of design are incorporated in the line of dry vacuum pumps presented in Bulletin No. 710, which the Chicago Pneumatic Tool Company, New York, has recently issued. The pumps described and illustrated are of the steam, belt and motor driven types and are particularly suited for service in power plants, gasoline extraction plants, chemical works, sugar houses, canneries, etc.

Pumps.—The Sullivan Machinery Company, Chicago, Ill., has recently issued three new bulletins, Nos. 71-G, 71-F and 70-W, describing in detail, in pictures and in diagrams the construction and operation of its air lift pumps, displacement pneumatic pumps and rotator hammer drills. The pneumatic pumps are an entirely new line intended primarily for handling acid, but are also used for pumping any liquid when local conditions make this form of pump desirable.

Radial Wall Drill.—The Pawling & Harnischfeger Company, Milwaukee, Wis., has recently issued Bulletin No. 206 describing its No. 6 radial wall drill which has been designed to meet the demand for a simple and effective machine for drilling, reaming and countersinking large unwieldy pieces. Examples of interior and exterior drilling of large steel drums and the drilling and reaming of structural material are shown in the bulletin, also dimension drawings.

Self-Opening Die Heads.—The different styles of H & G die heads are pictured and described in detail in a simple manner in a new catalogue of 93 pages, recently issued by the Eastern Machine Screw Corporation, New Haven, Conn. Much valuable data which should be useful to the man working out threading problems has been compiled and included in this unusual catalogue, also a number of illustrations showing the die heads installed on lathe and screw machines.